EXHIBIT 28

Prepared for

Monsanto Company et al.
Spokane, Washington

MICHAEL C. KAVANAUGH, EXPERT REPORT

CITY OF SPOKANE, A MUNICIPAL CORPORATION LOCATED IN THE COUNTY OF SPOKANE, STATE OF WASHINGTON, V. MONSANTO COMPANY, SOLUTIA INC., AND PHARMACIA CORPORATION AND DOES 1 THROUGH 100
UNITED STATES DISTRICT COURT FOR THE EASTERN DISTRICT OF WASHINGTON
No. 2:15-cv-00201-SMJ (E.D. Wash.)

Prepared by

Michael C. Kavanaugh
Michael C. Kavanaugh, Ph.D., P.E. (CA), BCEE
Senior Principal

Geosyntec consultants
engineers | scientists | innovators

1111 Broadway, 6th Floor
Oakland, California 94607

15 November 2019

EXECUTIVE SUMMARY

My name is Michael C. Kavanaugh, Ph.D., P.E., BCEE, and I am a Senior Principal at Geosyntec Consultants, Inc. (Geosyntec). I was retained by counsel for Monsanto Company (Monsanto) to formulate opinions on damage claims for upgrades to Spokane's storm water and wastewater treatment systems allegedly due to chemicals produced at one time by Monsanto. These claims are summarized in part in a complaint titled "City of Spokane, a municipal corporation located in the County of Spokane, State of Washington v. Monsanto Company, Solutia Inc., and Pharmacia Corporation, and Does 1 through 100" (Complaint). This Report provides a summary of those opinions, the bases for the opinions, as well as rebuttal opinions to expert reports recently prepared by plaintiff experts in this matter. The Report has been prepared by me and Geosyntec staff under my direction. I am a registered professional chemical engineer (PE) in California and a Board-Certified Environmental Engineer (BCEE) by the American Academy of Environmental Engineers and Scientists, with certifications in water and wastewater management, sustainability, and site remediation and hazardous waste management. I have more than forty years of academic, research, and consulting experience in the fields of sanitary engineering, environmental and chemical engineering, water chemistry, and hydrogeology related to a wide range of environmental issues. I am also an elected Fellow of the Water Environment Federation. For my contributions to water quality improvement and hazardous waste management, I was elected into the National Academy of Engineering (NAE) in 1998, the highest national recognition that can be achieved by a practicing engineer. My resume including a list of my publications is provided in Appendix A. Appendix B lists my testimony in depositions or trials in the past four years. My compensation for this matter is $375 per hour.

In formulating my opinions,[1] I have relied upon my review of documents prepared by others concerning the Spokane River. These hundreds of documents are related to the City of Spokane's wastewater and storm water treatment history, include reports on the environmental history of the Spokane River, and the surrounding area potentially affecting the river, and depositions of the parties and other witnesses. I have also relied upon my education and experience, and reference texts that are accepted and considered reliable by experts in the fields of sanitary and environmental engineering, chemical engineering, hydrogeology, and environmental chemistry. I have personally visited Spokane and toured the relevant stormwater and wastewater facilities on two occasions. During these visits I have inspected the Riverside Park Water Reclamation Facility

[1] I reserve the right to modify any of the opinions stated in this Report should additional documentation become available relevant to the facts in this matter. I may also provide supplemental opinions, if requested.

(RPWRF), existing combined sewer overflow (CSO) control structures, sites of ongoing CSO control system construction, and areas where the City is in the process of installing stormwater control infrastructure.

The complaint presented by the City of Spokane (referred to as "City" hereafter) alleges that "*Spokane has been and will continue to be legally obligated to spend money to remove PCBs from wastewater and stormwater before discharging into the Spokane River*" (City, 2015d; p. 34). However, the City's costs for managing stormwater and wastewater through upgrades to their infrastructure result entirely from failure to meet the requirements of the 1972 Clean Water Act (CWA) and subsequent Washington State and federal requirements. Failure to meets these requirements is due to infrastructure management problems facing the City of Spokane for over a century. None of the past or future costs for these upgrades are due to the presence of PCBs in the stormwaters and wastewaters in Spokane. In addition, the City claim conflates PCBs produced prior to Monsanto voluntarily ceasing production of PCBs in 1977, which will be described in this report as "product PCBs", and PCBs which were, and continue to be produced as a manufacturing by-product of many industrial chemical processes (Grossman, 2013). These "by-product" PCBs, sometimes described as inadvertent PCBs, are present in many commercial products, and found in wastewaters and stormwater and are unrelated to Monsanto. Based on my review of documents listed in Section 4 of this report, my professional knowledge and experience and site observations, I have reached the following opinions:

1. **The City has been ordered to control the discharge of raw sewage to the Spokane River for over 100 years and is still (in 2019) not in compliance.**
2. **The upgrades to the stormwater and wastewater system were planned decades before PCBs were detected in the Spokane River.**
3. **The alleged damages that the City attributes to PCBs are in fact related to long overdue upgrades to the City's stormwater and wastewater systems.**
4. **The City concedes that all aspects of the design, construction, and operation of the planned or implemented upgrades to the storm water and wastewater systems are required independent of the presence of PCBs.**
5. **The Spokane River currently complies with the applicable water quality criterion for PCBs. There is no regulatory requirement for the City to take any action to reduce PCB discharges from the storm water or wastewater systems.**

6. **The mass of PCBs currently being discharged from City's storm water and wastewater systems is de minimis and will not materially affect the Spokane River's water quality.**

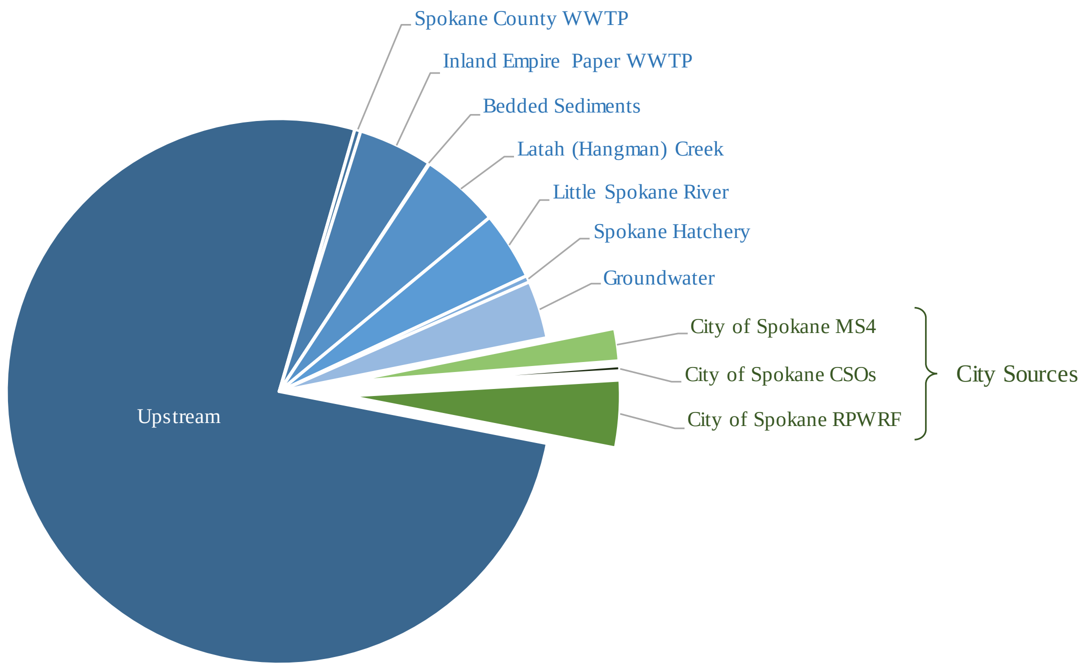

Exhibit ES-1: The vast majority of PCB loading in the Spokane River is outside the control of the City of Spokane
Source: Dilks, 2019-Table 1.

7. **Dr. Trapp proposes a stormwater capture alternative which is unprecedented, infeasible, unreasonable, is not required under the City's stormwater management permit, and seeks redundant costs already claimed by the City.**

8. **Mr. Bowdan's claim that future costs to operate and maintain the upgraded wastewater treatment plant in the non-critical season is due to PCBs has no basis in fact and the City has admitted that these costs are unrelated to PCBs.**

Geosyntec consultants

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF EXHIBITS

LIST OF ACRONYMS AND ABBREVIATIONS

2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzodioxin
AKART	All Known Available and Reasonable methods of prevention, control and Treatment
ARRA	American Recovery Reinvestment Act
BCEE	Board Certified Environmental Engineer
BAT	Best Available Technology
BMP	Best Management Practices
BOD	Biochemical Oxygen Demand
CBOD	Carbonaceous Biochemical Oxygen Demand
CEPT	Chemically enhanced primary treatment
CFR	Code of Federal Regulations
CFU	Colony forming unit
City	City of Spokane
COD	Chemical Oxygen Demand
CSO	Combined Sewer Overflow
CSS	Combined Sewer System
CWA	Clean Water Act
DO	Dissolved oxygen
Ecology	Washington State Department of Ecology
FDA	Food and Drug Administration
FWPCA	Federal Water Pollution Control Act
Geosyntec	Geosyntec Consultants, Inc.
GI	Green Infrastructure
IEP	Inland Empire Paper Company
I/I	Infiltration and Inflow
Kaiser	Kaiser Aluminum and Chemical Corporation – Trentwood
Lbs	Pounds
LID	Low Impact Development
LLC	Limited Liability Corporation
MCL	Maximum Contaminant Level
Mg	Milligrams
L	Liter
MG	Million gallons
MGD	Million gallons per day
MS4	Municipal Separate Storm Sewer System
NAE	National Academy of Engineering
NLT	Next Level Treatment
NPDES	National Pollutant Discharge Elimination System

NTR	National Toxics Rule
O&M	Operations and Maintenance
PBDE	Polybrominated diphenyl ethers
PAHs	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyl
P.E.	Professional Engineer
pg/L	Picograms per liter
POTW	Publicly Operated Treatment Works
ppb	Parts per billion
ppm	Parts per million
ppq	Parts per quadrillion
QAPP	Quality Assurance Project Plan
RFP	Request for Proposal
RPA	Reasonable Potential Analysis
RPWRF	Riverside Park Water Reclamation Facility
SAP	Sampling and Analysis Plan
SCRWRF	Spokane County Regional Water Reclamation Facility
SURGE	Spokane Urban Runoff Greenways Ecosystem
SRRTTF	Spokane River Regional Toxics Task Force
STP	Sewage Treatment Plan
SWMP	Stormwater Management Plan
SWPPP	Storm Water Pollution Prevention Plan
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids
UIC	Underground Injection Control
URO	Urban Run-Off
USACE	United States Army Corp of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WA	Washington
WAC	Washington Administrative Code
WWTP	Waste water treatment plant
µg/L	Micrograms per liter

1. BASIS OF OPINIONS

Since the establishment of the City of Spokane (City), the Spokane River has served as the primary disposal option for its municipal wastewaters. As the City has grown, the use of the River for disposal of these wastes has resulted in significant degradation of water quality in the River and limited the beneficial use of this resource. Over the years, the degradation of water quality has drawn increasing regulatory scrutiny and demands from the community to cease the discharge of undertreated municipal and industrial wastewaters to the River.

Since the passage of the Clean Water Act (CWA) in 1972, the City has been required to take mitigation measures to reduce these discharges and make the necessary capital and operational investments to achieve compliance with various permits established under the CWA. Currently, the City must meet permit requirements established under the National Pollutant Discharge Elimination System (NPDES) permits for discharge of stormwater and wastewater. These permits have established requirements for discharges from three elements in the wastewater and stormwater infrastructure, namely the City's wastewater treatment plant, the separate sewer system, and the combined sewer system. In particular, the City must reduce the frequency of combined sewer overflow (CSO) events which discharge untreated wastewater (i.e. sewage) and stormwater into the River. This phenomenon occurs during storm events when the hydraulic capacity of the wastewater treatment plant is exceeded by combined sewage and stormwater flows, resulting in bypassing the treatment plant and direct discharge of the untreated wastes to the River.

The federal government, through the United States Environmental Protection Agency (USEPA) in combination with the Department of Ecology in the State of Washington, (Ecology), specifies the procedures and actions that the City must carry out to manage wastewater and stormwater to protect human health and the environment, including protection of the beneficial uses of the River. These actions include, among other activities, significant upgrades to the wastewater treatment plant, expansion of the stormwater control systems, and installation of storage systems that can reduce the frequency of combined sewer overflows to a level that meets permit requirements. Operation of these systems also requires routine monitoring for a wide range of chemical, microbial and physical constituents present in wastewater and stormwater.

To meet these regulatorily mandated requirements, the City has made large capital investments and expects to incur future costs. The City alleges that these past costs for necessary system upgrades are due to the presence of a single group of chemicals present in the Spokane River, namely, polychlorinated biphenyls or PCBs. The City further

alleges that future costs are also due exclusively to the presence of these chemicals in the River.

In my opinion, however, the past and future costs incurred by the City are driven entirely by the City's requirement to be in compliance with the permits issued under the CWA and are unrelated to the presence of PCBs in the Spokane River. These past and future costs would be no different had PCBs never been invented. The City inaccurately ascribes the costs to meet these requirements to undertake historical, current, and future mitigation measures for control of the discharge of stormwater, wastewaters and combined sewer overflows to the presence of PCBs in stormwater and wastewaters managed by the City.

The City of Spokane (City) claims damages under three primary categories (City, 2019a):

1. Past costs incurred historically by the City for planning and implementation of stormwater control measures and upgrades to the wastewater treatment system;
2. Future costs that may be incurred for stormwater and wastewater control systems; and
3. Conceptual and estimated future costs for supplemental operation of a next level treatment (NLT) system during 4 months of the year, characterized as the Non-Critical Season for control of phosphorus loading to the Spokane River.

These claims have been presented in detail in Plaintiff's Third Supplement to Plaintiff's Second Amended Responses to Interrogatories (City, 2019a). The remainder of the claims is related to preparation of an Integrated Clean Water Plan (Integrated Plan; CH2MHill, 2014b), interest on various loans and bonds the City has taken out for its infrastructure improvements, participation in the Spokane River Regional Toxics Task Force (SRRTTF), and related studies.

For the purposes of this report, PCBs that were historically manufactured and incorporated into products for their beneficial physical and chemical characteristics are referred to herein as "product PCBs". These PCBs are distinguished from "by-product PCBs", PCBs which were, and continued to be legally produced to this day through manufacture of a wide range of commercial products. In order to understand the context of these claims and my bases for refuting the premise that they are due to product PCBs in the stormwater and wastewater, my Report provides a description of general stormwater and wastewater management and the requirements established under the CWA that the City is obligated to satisfy. A brief summary of the characteristics of PCBs, how they are formed and used commercially, and how they behave in the soil and aqueous environment once released from their sources is included in Appendix C.

2. OPINION 1: THE CITY HAS BEEN ORDERED TO CONTROL THE DISCHARGE OF RAW SEWAGE INTO THE SPOKANE RIVER FOR OVER 100 YEARS AND IS STILL (IN 2019) NOT IN COMPLIANCE

The City, by account of its long history of deferring necessary stormwater and wastewater management infrastructure upgrades required by the State of Washington and the USEPA, has contributed and continues to contribute to degradation of water quality in the Spokane River.

The Spokane River has had historic water quality problems resulting from untreated sewer and industrial wastewater discharges; upstream mining industry releases; stormwater runoff; runoff of fertilizer-related constituents from regional agriculture; suspended sediment from soil erosion; various local industrial sources; and discharges from CSOs and publicly owned treatment works (POTWs) (CH2MHill, 2014b; Ecology, 2012). Despite multiple orders and letters from the State of Washington, the City continued to delay system updates beginning in 1909 and extending to the present day. The following chronology outlines the numerous occasions where the City delayed responding to regulatory mandated system upgrades for stormwater and wastewater management or delayed adoption of generally accepted standard practices for the time.

As compared to other urban areas, the City was late to adopt a sewer system. In 1880, 63% of urban areas in the US were served by sewers, increasing to 72% by 1890 (Melosi, 2000). It was not until June of 1889 that the City first installed a single sewer line in Howard Street from First Avenue to the river (Esvelt and Saxon, 1972). During the 1890s, the City's wastewater treatment system consisted of gravel shelves over which the wastewater ran before discharging into the Spokane River (Soltero et al., 1990). This type of direct sewer discharge to surface waters was generally accepted practice in the early 1900's in the U.S. and the related effects to receiving water bodies were an accepted consequence (Soltero et al., 1990). The Spokane Historical summarized river conditions in the early 1900s:

> "*Dumping untreated sewage into the river compromised the city's drinking water source. In the early 1900's a series of typhoid outbreaks ravaged the city. In September 1909, there were sixty-four cases reported in just one week, and seventy-four cases were reported in August 1910. The outbreaks were attributed to the pollution of the river and the city was forced to add a new source of fresh water, eventually discovering one in the aquifer. Some efforts were made to alleviate the pollution but the city did not begin construction on a wastewater*

treatment plant until 1952, thirteen years after Coeur d'Alene opened their plant."[2]

With unprecedented population growth in urban areas, and increased knowledge of the effect of these discharges on the quality of surface water bodies, larger cities transitioned to centralized collection and treatment practices during the early 20th century (Burian et al., 2000). However, the City did not follow its peers or even state orders. A report by Bovay Engineers documents this historical failure of Spokane to respond to Washington State requirements for protection of water quality:

> *"The Washington State Department of Health in 1909 and 1929 ordered the City to cease and prevent any further dumping of sewage into the river. In both cases, the City took no action and the State did not pursue the matter"* (Bovay, 1994; p. 2-9).

The City continued to lag compared to peer cities, as elsewhere in the United States, 20% of cities had implemented some form of primary wastewater treatment by 1920, and 50% had adopted treatment by 1940 (Melosi, 2000; Exhibit 2-1).

Year	% of US Cities with Primary Wastewater Treatment
1920	20%
1940	50%
1945	62.7%
1957	77.7%

Exhibit 2-1: Percent of US Cities with Primary Wastewater Treatment by Year
Source: Melosi, 2000

In contrast, by the 1920s, the City was the second largest city in Washington, but it continued to discharge to the river, exceeding the river's dilution capacity and resulting in raw sewage visible in the river (Soltero et al., 1992). This practice continued into the early 1930s, where "*riverine sludge deposits, low dissolved oxygen levels, and pathogenic hazards were linked to the raw sewage discharges along the river*" (Soltero et al., 1992; p. 459). In 1933, a Report on Sewage Disposal to the City's engineer recommended construction of an interceptor system to convey sewage to a treatment plant, but bond measures to install the interceptor lines were defeated in 1933 and 1937 leading to the continued discharge of untreated wastewater (Soltero et al., 1992).

The continued and increasing discharge of untreated sewage to the Spokane River presented ever-increasing water quality problems, which did not go unnoticed by the State

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[2] Logan M. Camporeale, "Riverside Park Wastewater Treatment Plant," Spokane Historical, accessed January 4, 2018, http://www.spokanehistorical.org/items/show/726

Health Department. According to the City Engineer's office in its 1945, *History of the Spokane Sewage Treatment Plant*, the State Health Department's director, E.R. Coffey, sent a communication to City Council on August 3, 1933, advising, *"Spokane is violating the State law by discharging raw sewage into the Spokane River"* (City, 1945; p. 2). However, the City once again did not take immediate action. As noted later in this same historical account:

> *"On December 4, 1936 the State Health Department, through its director, E.R. Coffey, notified the City of Spokane to start within 90 days, the abatement of the nuisance resulting from the discharge of raw sewage into the Spokane River and to have the abatement completed within 365 days from the date of the notice…On December 5, 1936 the City Council adopted a resolution requesting an extension of one year's time in connection with the notice…This extension was granted to December 4, 1937"* (City, 1945; p. 2-3).

In 1945, as the City continued to delay abatement of discharging untreated sewage and failed to pass bonds, Washington State created the Pollution Control Commission and passed its first law protecting the quality of state waters (Revised Code of Washington, Chapter 90.48). In response to this law, the City finally approved a bond in 1946 and began building its first treatment plant, which would eventually be called the Riverside Park Water Reclamation Facility (RPWRF).

In 1948, the federal government passed the predecessor to the CWA—the Federal Water Pollution Control Act (FWPCA). Over the next 24 years, this Act provided money to states to fund water protection projects including the construction of POTWs, to establish the Federal Water Pollution Control Administration, and set water quality standards for interstate waters until 1970, when President Nixon created the USEPA as the lead federal agency to enforce environmental statutes (USEPA, 2010). Although 75% of cities in the US had primary wastewater treatment installed before Spokane, which did not have primary wastewater treatment until 1958, 12 years after the City's wastewater bond was passed. The City's initial Primary Wastewater treatment plant provided only primary treatment, including grit removal, primary clarification, and chlorine disinfection (Esvelt & Saxon and Bovay Engineers, 1972). Furthermore, its completion had not stopped untreated sewage entering the Spokane River, 21 years after the deadline the State Health Department granted the City Council's requested extension.

In 1962, the City expanded the nominal treatment hydraulic capacity of the plant to 50 million gallons per day (MGD). However, flows during storm events would still routinely exceed the individual conveyance capacity or the overall hydraulic treatment capacity of the RPWRF. As a result, a portion of the combined wastewater and stormwater would

bypass the RPWRF and discharge directly to the Spokane River through 44 CSO outfalls or through the bypass outfall at the RPWRF (Esvelt & Saxon and Bovay Engineers, 1972; City, 2016c). To address this problem, the Washington State Water Pollution Control Commission initiated action in March 1968, requiring the City to upgrade the POTW to provide secondary treatment and improved disinfection. In addition, the City was required to evaluate the nature and magnitude of excessive flow problems, determine the most feasible method to control or eliminate combined sewage, and develop a phased construction program and cost analysis to complete these projects (Esvelt & Saxon and Bovay Engineers, 1972).

On January 8th, 1970, Ecology ordered the City to prepare a study by July 31st, 1972 to provide *"an orderly program which will eliminate those overflows of untreated sanitary sewage into the Spokane river that are caused by storm water and/or infiltration"* (Ecology, 1972; p. 3).

Two years later, Ecology documented the City's complete lack of meaningful efforts in complying with Ecology's directive, issuing a Notice of Violation in November 1972, for failure to upgrade the sewage treatment plant or to address CSO overflows stating the following:

> "*you have given us little alternative in this matter due to the lack of physical improvements since March of 1968 when the waste treatment improvement requirements and elimination of storm water overflows were first outlined for the City of Spokane…we have tried, in every way available to us to cooperate with the City of Spokane in this matter of providing necessary waste treatment improvements and storm water separation facilities. We feel strongly that the City of Spokane has not made a meaningful effort to respond in kind to our cooperative efforts. If we do not receive your absolute cooperation in compliance with the time schedules and submission dates described in the enclosed Notice, we will have no alternative but to enter into whatever legal action is necessary to obtain compliance and to protect the quality of the public waters involved.*" (Ecology, 1972; p. 2).

This notice required that the advanced (secondary) wastewater treatment plant be completed and placed in operation by October of 1975 and that overflows be eliminated from its combined sewer system (CSS) *"on a timely basis and will not be set back out of deference to the City's actions pertaining to the required sewage treatment plant improvements, or to any other cause within the control of the City of Spokane"* (Ecology, 1972; p.3).

The FWPCA was further amended in 1977 when the statute was expanded and renamed as the CWA. Under the CWA, the Best Available Technology (BAT) Economically Achievable controls were expanded, and new controls for the conventional parameters[3] and industrial pretreatment programs were established for industries discharging wastewaters to POTWs.

In response to the CWA, the USEPA initially issued "individual" National Pollutant Discharge Elimination System (NPDES) permits on a facility-by-facility basis (Ecology, 2010a; USEPA, 2010). The NPDES permit allows for a point source, such as a POTW, to be authorized to discharge a specific amount of some of the constituents found in wastewaters into the waters of the United States.

These orders, beginning in 1909 from the State Health Department and continuing through the City's current stormwater and wastewater permits issued by Ecology, form an unbroken chain of regulatory demands to control wastewater, stormwater, and untreated sewage discharges to the Spokane River. The City has deferred and delayed compliance with these regulations for over a century. Although PCBs had yet to be detected in the river when these requirements were first established in 1970, the City is now looking to Monsanto to fund its stormwater and CSO control costs. As discussed above, these requirements were delayed for decades and are now alleged to be related to the control of PCBs. In fact, all of these past and future alleged costs are the consequence of the City's obligations to meet the requirements of the various State and federal statutes designed to protect the water quality of the waters of the United States, which in this case, is the Spokane River. The City's well documented delays in meeting these requirements has also increased their costs, again unrelated to the presence of PCBs, due to cost inflation over time.

2.1 Overview of Wastewater and Stormwater Management Systems

To provide context on the City's historic and existing stormwater and wastewater infrastructure and planned infrastructure improvements, a brief overview of stormwater and wastewater constituents and management systems is presented below.

Wastewater can generally be categorized as a combination of municipal and industrial wastewaters, which in some instances are conveyed in separate conveyance systems from stormwater (Exhibit 2-2), and in some cases through a combined sewer system (CSS) (Exhibit 2-3). CSSs are generally prevalent in older wastewater infrastructure systems

[3] Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), pH, fecal coliform, and oil and grease.

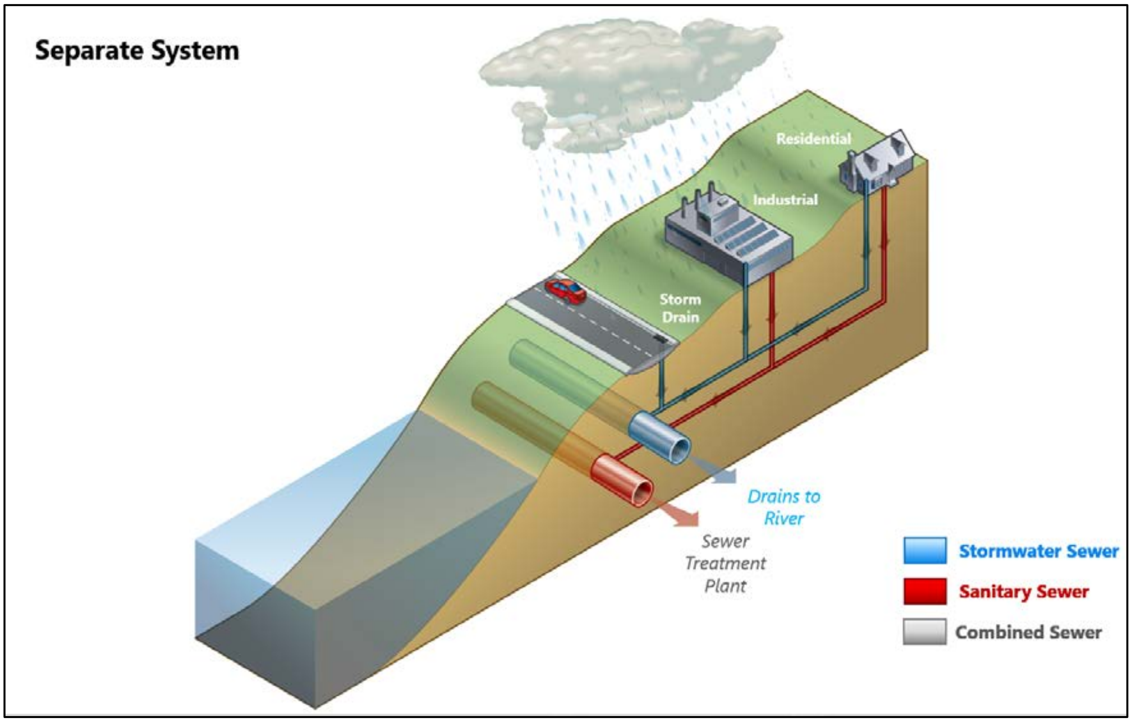

Exhibit 2-2: Example of a Separate Sanitary and Stormwater Conveyance System

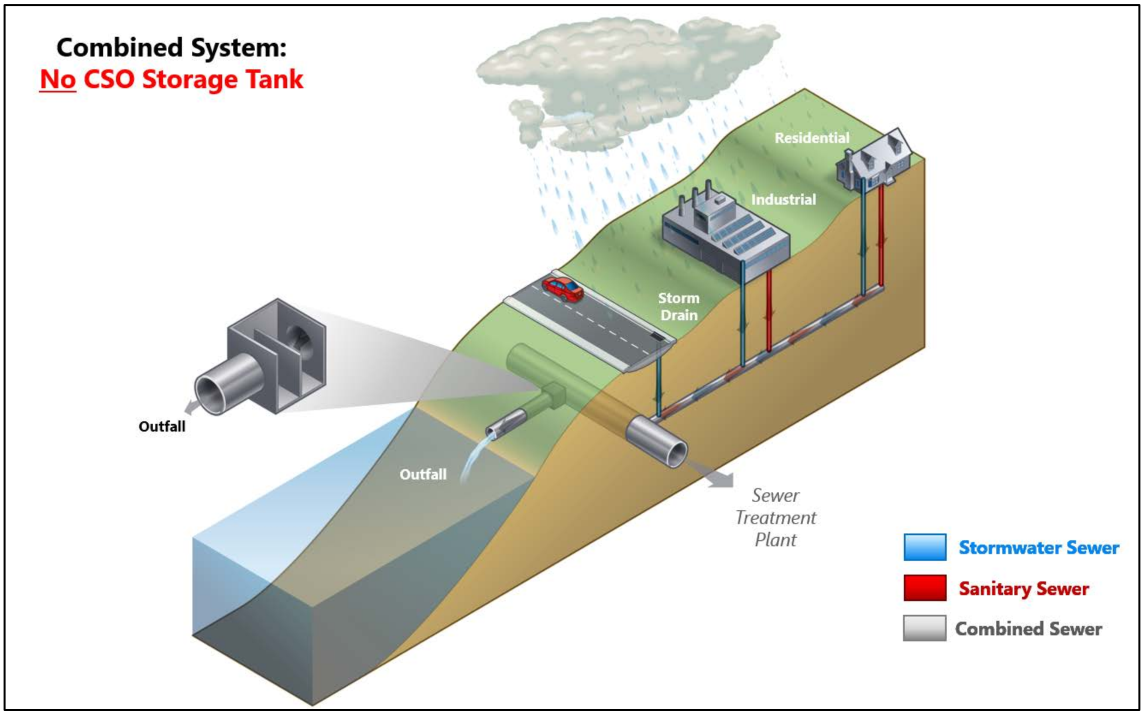

Exhibit 2-3: Example of a Combined Sanitary and Stormwater Conveyance System

including the City. Sanitary or municipal wastewater includes sewage and household wastewater from residences and commercial locations. Industrial wastewater generally includes effluent from facility wastewater treatment systems that treat raw industrial wastewater to acceptable limits before discharging to a POTW. Stormwater refers to runoff from precipitation events and melting snow.

When a sudden influx of stormwater or snowmelt enters a CSS, the total water flow can exceed the hydraulic capacity of the system to treat the wastewater. To prevent backflow into residences or damage to the POTW, the excess combined wastewater and stormwater is diverted to CSO outfalls. To mitigate these discharges, CSO storage tanks can be installed to store the excess sewage and stormwater until it there is sufficient capacity to return the water to the treatment plant. If the overflow volume exceeds the storage capacity of the tank, an overflow occurs (Exhibit 2-4).

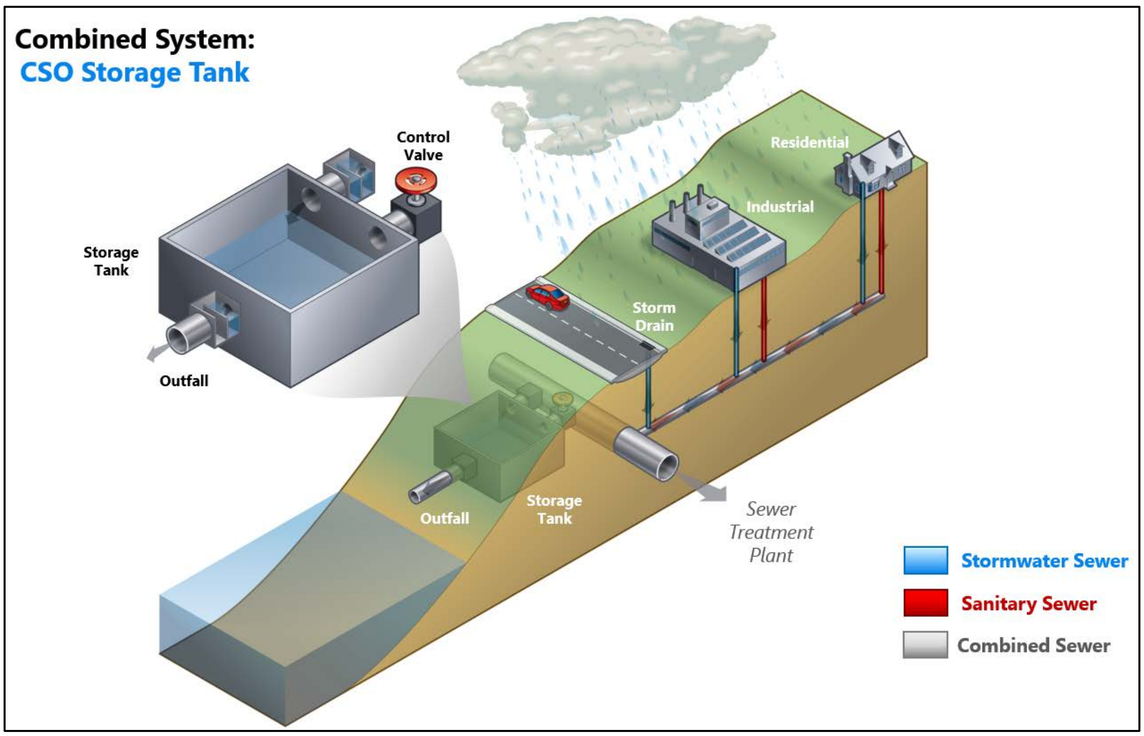

Exhibit 2-4: Example of a Combined Sanitary and Stormwater Conveyance System with a CSO storage tank

2.2 Wastewater Treatment

Wastewater treatment systems have evolved as requirements for treatment have expanded. Wastewater treatment is generally accomplished in a series of stages or

treatment units that increase treatment effectiveness. Increasing levels of treatment are typically referred to as primary, secondary, and tertiary treatment stages.

2.2.1 Primary Treatment

During primary treatment, the wastewater passes through screens and sedimentation basins to capture the larger or heavier suspended solids (Exhibit 2-5). A majority of the suspended solids, including organic and inorganic constituents bound to the suspended solids, are removed during primary treatment (Metcalf & Eddy et al., 2013).

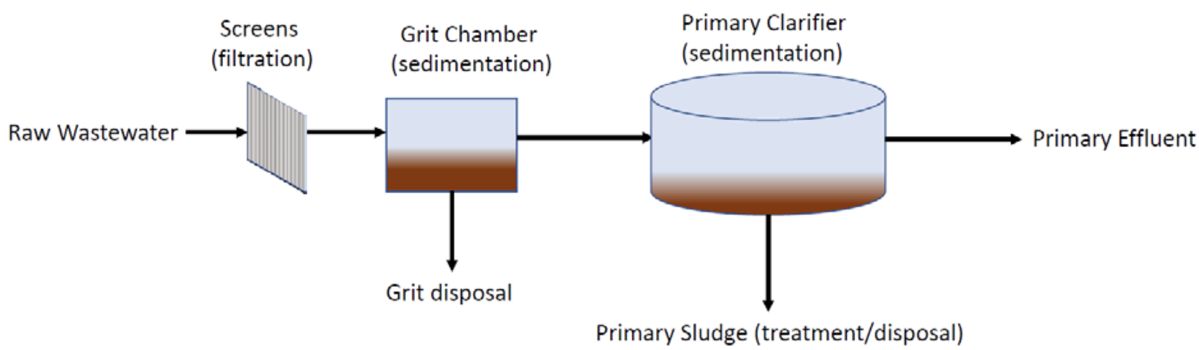

Exhibit 2-5: Wastewater Primary Treatment Schematic

2.2.2 Secondary Treatment

Secondary treatment generally consists of a biological process, usually under aerobic conditions (i.e. presence of oxygen) to further reduce the organic content of the wastewater. Because the biological process produces microbial biomass, a settling process is needed to remove the biomass and reduce suspended solids in the effluent from the secondary treatment plant. The biomass is recirculated to promote the further reduction of biochemical oxygen demand (BOD) in the system (Metcalf & Eddy et al., 2013; Exhibit 2-6). Secondary treatment in some facilities also targets removal of nutrients such as nitrogen and phosphorus. The effluent from secondary treatment typically still contain some level of organic and inorganic constituents including phosphorus. In most situations in the U.S., secondary effluent is subjected to disinfection using either chlorine or ultraviolet agents before discharge to surface water to reduce the microbial density to acceptable levels.

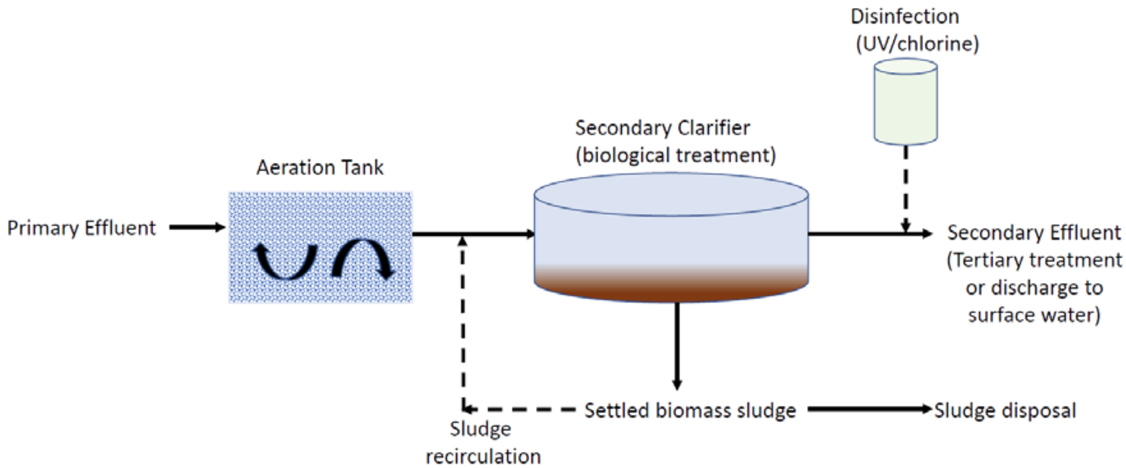

Exhibit 2-6: Wastewater Secondary Treatment Schematic

2.2.3 Tertiary Treatment

Tertiary treatment generally refers to a third stage that contains a process that targets the remaining suspended solids following secondary treatment as well removal of target dissolved constituents such as phosphorus. Technologies used in this stage include granular media filters, activated carbon columns, or certain kinds of membranes to remove both particulate and dissolved constituents that are not effectively removed by primary or secondary treatment (Metcalf & Eddy et al., 2013; Exhibit 2-7). Examples of tertiary treatment systems include nutrient removal systems (e.g., phosphorus or nitrogen removal. In some cases, the efficiency of this step is further enhanced by adding chemicals that can combine with the dissolved phosphorus and produce solid materials that can be removed. These chemicals also enhance removal of total suspended solids (TSS) in the filtration step thus removing more particulates and reducing the chemical load associated with the particulates (e.g., phosphorus). The decision to use primary, secondary, and/or tertiary treatment systems and the process components within the treatment system(s) depends on the types and concentrations of constituents in the wastewater and the permit conditions defining the allowed quality of the treated wastewater that can be discharged.

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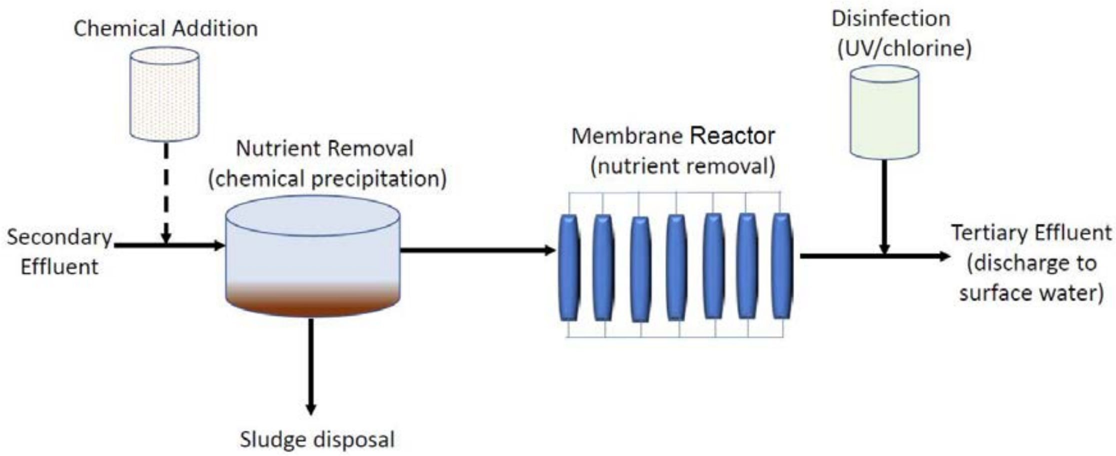


Exhibit 2-7: Wastewater Tertiary Treatment Schematic

2.2.4 Stormwater Treatment

The most prevalent constituent transported by stormwater is suspended solids. Suspended solids in stormwater typically result from particulate matter (e.g., dust, soil, debris) on streets being washed into wastewater collection systems (Exhibit 2-8). There is also a wide range of other organic and inorganic constituents contained in stormwater flows which can have adverse effects on receiving waters.

Common Sources of Stormwater Pollution addressed by Best Management Practices	
	TSS from construction sites and erosion from yards and slopes.
	BOD commonly caused by degradable organic material (e.g. animal waste, compost, mulch, and plant debris).

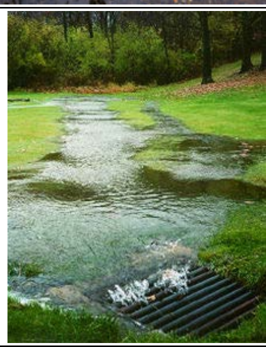
Common Sources of Stormwater Pollution addressed by Best Management Practices	
	Metals (zinc, copper, lead, cadmium chromium, arsenic) from auto-shops, and wear and tear of brake pads.
	Oils, greases and other organic compounds, fuel and oil drips and spills, asphalt, and coal-tar sealants.
	Nutrients including phosphorus and ammonia in runoff from lawns and farms, fertilizers, lawn clippings, septic systems.
	Pathogenic organisms including bacteria, viruses and protozoa from animal waste.

Exhibit 2-8: Common Sources of Stormwater Pollution Addressed by Best Management Practices
Source: City, 2008; USEPA, 2005

Basic stormwater management begins with source control and housekeeping practices, and preparation of a storm water pollution prevention plan (SWPPP) to keep spills, debris, sediment, and other constituents from entering stormwater. These stormwater treatment techniques involve several types of best management practices (BMPs) which are schedules of activities, prohibitions of practices, maintenance procedures, managerial practices, or structural features that prevent or reduce constituents being discharged to the

environment (Ecology, 2014). BMPs can be divided into source controls, treatment, and flow controls.

Source control BMPs work to prevent migration of many constituents to water bodies through methods such as placing roofs over operational areas which may contribute to stormwater, general site housekeeping, street sweeping, and business inspections. Treatment BMPs remove constituents from stormwater through filtration, centrifugal separation, or adsorption of constituents onto various media or soils during infiltration of the stormwater into the ground. Flow control BMPs such as detention ponds, or fiber rolls, reduce the volume or flow rate of stormwater to reduce the load of suspended sediment and associated constituents in the stormwater flow (Spokane County, City of Spokane, and City of Spokane Valley, 2008). This allows accumulated sediments to settle and for stormwater flows to infiltrate into the groundwater rather than discharge directly to surface water bodies (Ecology, 2014). Active stormwater treatment technologies are employed to achieve high efficiency particulate removal from the stormwater stream and are very similar in approach and function to the filtration processes used in tertiary wastewater treatment. These approaches may include sand filtration, and enhanced flocculation approaches to meet sediment/constituent removal goals.

2.2.5 Common Characteristics of Wastewater and Stormwater

Wastewater and stormwater have multiple and varied sources, resulting in a mixture of many constituents representing a range of physical, chemical, and biological characteristics (Metcalf & Eddy et al., 2013). These waste streams are characterized using multiple analytical techniques that specify the concentrations of both individual constituents (e.g. metals or specific organic chemicals such as PCBs) or collective parameters (e.g. BOD) that provide a basis for management strategies to meet discharge or reuse requirements of the waste streams.

Physically, the constituents in wastewater and stormwater are broadly classified as being either dissolved or particulate, with the distinction based on size (Metcalf & Eddy et al., 2013). The mass of particulates present in a waste stream is determined by measuring the mass of particulates larger than approximately 0.5 microns and reported as TSS. Particulates can consist of diverse materials with organic, inorganic, or microbial origin. Individual chemical species may be present in either the dissolved or particulate state, depending on the nature of the chemical and the overall chemical composition of the waste stream.

Chemically, wastewater and stormwater contain both organic (carbon-based) and inorganic constituents. Organic constituents that are degradable through aerobic

biological treatment are characterized by measuring the BOD over a fixed period of time, usually five days. The fraction that is not susceptible to aerobic biological treatment is included in measurement of the chemical oxygen demand (COD). Organic compounds reported in wastewater and stormwater include oils, grease, fats, surfactants, soaps, detergents, pesticides and, to a lesser extent, trace compounds such as polycyclic aromatic hydrocarbons (PAHs), dioxins and furans, solvents, and total PCBs (Metcalf & Eddy et al., 2013) among others. The inorganic fraction primarily includes various metals, and forms of nitrogen, and phosphorus.

Wastewater and stormwater also contain various microorganisms, including pathogens, plant matter and micro-fauna including vertebrates and invertebrates. These biological components are almost completely associated with the TSS or particulates present in the wastewater (Metcalf & Eddy et al., 2013).

In context of the stormwater and wastewater infrastructure discussed above, a timeline of the City's adoption of mandated and generally acceptable stormwater and wastewater management standards of the time in comparison to the rest of the country and similarly sized cities in Washington is discussed below in Opinion 3.

3. OPINION 2: THE UPGRADES TO THE STORM WATER AND WASTEWATER SYSTEMS WERE ORDERED AND PLANNED DECADES BEFORE PCBS WERE EVER DETECTED IN THE SPOKANE RIVER.

The Spokane River has been used for decades to dispose of untreated or undertreated municipal and wastewater discharges. As discussed in Opinion 1, the City was ordered to take actions to correct these discharges and bring its system into compliance with the CWA requirements. These actions are required to meet basic wastewater and stormwater permit conditions and include routine monitoring for a wide range of constituents. Under the CWA, 126 priority pollutants have been identified which are required to be controlled under the NPDES permit program. The requirements for the management of the City's wastewater and stormwater programs are based on compliance with the permits issued under authorization of the CWA. The City's requirements for management of its wastewater and stormwater and the engineered upgrades required under the CWA would be no different had PCBs never been invented.

Spokane's long history of failure to plan and implement controls for its CSO system have nothing to do with the presence or absence of PCBs in the CSO discharges. The need to implement these CSO controls, and the related costs to the City would be exactly the same in the absence of product PCBs. Ecology first sampled the Spokane River for PCBs in 1993, decades after the City was ordered to control its stormwater and wastewater discharges to the river (Ecology, 1995). PCBs are not mentioned in any City stormwater or CSO planning document prior to the 2014 Integrated Plan. The City's CSO storage tanks (1972) and the Municipal Separate Storm Sewer System (MS4) basins (1980) were planned before any PCBs were detected in the Spokane River (1989) (City 30(b)(6), Hendron, 2019, 87, 88, 132).

3.1 <u>History of the Clean Water Act and NPDES Regulatory System</u>

The City alleges that the presence of total PCBs in wastewater managed by the City has resulted in additional costs associated with wastewater management. However, a review of the historical development of environmental regulations demonstrates that the City's costs are related to their delayed management of municipal stormwater and wastewater. Under the CWA, the USEPA established the NPDES permit system to regulate discharges of pollutants from municipal and industrial wastewater treatment plants, sewer collection systems, and stormwater discharges from industrial facilities and municipalities (USEPA, 2010).

3.1.1 Wastewater Regulatory History

Following the creation of the FWPCA in 1948, Washington State enacted the Pollution Disclosure Act in 1971, which required dischargers to use *"all known, available and reasonable methods of treatment [of wastewater] prior to discharge regardless of the quality of water"* (Ecology, 1994; p. 1). At the federal level, amendments to the FWPCA were passed in 1972 which included:

- Creation of the NPDES discharge permit program for conventional parameters such as BOD, TSS, pH, fecal coliform, and oil and grease applicable to both municipal and industrial dischargers;
- Establishing the federal government as the controlling body for water quality control and enforcement; and
- Defining procedures to achieve a balance between the environment and the economy.

The FWPCA of 1972 also set an interim goal of achieving "*water quality [that] provides for the protection and propagation of fish, shellfish, wildlife, and provides for recreation in and on the water*" by July 1, 1983 (USEPA, 2010; p.1-2). POTWs were required to meet secondary treatment standards by July 1, 1977 (USEPA, 2010). In 1973, the State of Washington became one of the first states to be delegated by the USEPA to administer NPDES permits in addition to its state permit program (Ecology, 1994). The FWPCA was further amended in 1977 when the statute was expanded and renamed as the CWA. Under the CWA, the BAT Economically Achievable controls were expanded, and new controls for the conventional parameters and industrial pretreatment programs were established for industries discharging wastewaters to POTWs.

In response to the CWA, the USEPA initially issued "individual" NPDES permits on a facility-by-facility basis (Ecology, 2010a; USEPA, 2010). As noted above, the NPDES permit allows for a point source, such as a POTW, to be authorized to discharge pollutants into waters of the United States. The permit controls the pollutants by two means: 1) technology-based limitations and 2) water quality-based limitations. Initial NPDES permits issued between 1973 and 1976 addressed *conventional pollutants*, such as BOD_5, TSS, pH, fecal coliform, and oil and grease. Permits issued after 1977 controlled *toxic pollutants/priority pollutants*; the CWA initially identified 65 toxic pollutants. This list has since grown from the initial 65 to 126 priority pollutants.

Individual permits continue to be issued. Additionally, in 1979, the USEPA created a class of permits called "general" NPDES permits; this allowed multiple facilities with similar discharges within a given geographic area to be managed under a single permit

(Ecology, 2010a). USEPA authorized Washington State to use the general permit approach in 1989. In 1990, the federal government amended the CWA to include regulations for managing non-point sources including stormwater (Ecology, 2010a).

3.1.2 Stormwater Regulatory History

Ecology started a permit program for MS4s in 1995, beginning with three general stormwater discharge permits in Western Washington. In 2007, Phase I General Permits were issued by Ecology to Clark, King, Pierce and Snohomish Counties and the cities of Seattle and Tacoma (incorporated cities with a population over 100,000 and unincorporated counties with populations of more than 250,000 according to the 1990 census); Phase II General Permits were issued in the same year to all regulated small municipal separate storm sewer systems in Eastern and Western Washington, respectively, including the City of Spokane (Ecology, 2011e).

Spokane operates its stormwater system under the Eastern Washington Phase II Municipal stormwater permit (Ecology, 2014), which does not contain a numeric discharge limit for PCBs. However, it does contain Total Maximum Daily Load (TMDL) based discharge limitations for phosphorus, ammonia and carbonaceous biochemical oxygen demand (CBOD) (City 30(b)(6), Davis, 2019a, 62:7-15)[4].

3.2 Spokane's Wastewater and Stormwater Management History

In 1970, Ecology issued a status report on Water Pollution in the Spokane River (Ecology, 1970) which first established the City's requirement to improve the wastewater treatment plant and control the volume and frequency of combined sewer storm water overflows:

> *"The requirements placed on the City involve two situations. They must (1) upgrade their existing primary treatment plan to secondary treatment, and (2) undertake a study and develop a plan for correction of the storm water overflow problems."*
>
> *"The Commission however, required that they design, finance and construct modifications to the existing sewage treatment plant by the end of 1972. These*

---

[4]Q: What's in the permit? What constituents is or are, or is the City of Spokane obligated to address with respect to the management of their stormwater system under Washington law?
A. Under the Phase II permit of the Eastern Washington Phase II stormwater permit, in the appendix they have the TMDLs. For the city it's the dissolved oxygen TMDL.
Q. And specifically it says dissolved oxygen total maximum daily load, the parameters are total phosphorus, ammonia and CBOD5. Correct?
A. That's what the permit says. Yes.

> *requirements have not been accepted by the City with enthusiasm. Without question, the City has expressed a very real concern as they face a problem of great magnitude. By the same token, the problems needing correction are also very real and the people of Spokane must face up to them."* (Ecology, 1970; p. 8 and p. 9)

3.2.1 1972 Action Plan

In response to the Water Pollution Control Commission's requirements, the City completed a study of the City's sewer system in 1972 and found that in-system deficiencies resulted in over 740 million gallons of CSOs discharging to the river in 1971-1972 (Esvelt & Saxon and Bovay Engineers, 1972). The study also investigated potential remedies to reduce and/or eliminate untreated CSOs to the Spokane River. The study found that during an average year, it was estimated that nearly 1,000 overflow events occurred each year, discharging over 725 million gallons of untreated wastewater to the river (City, 2016c). The City considered implementation of secondary treatment, an increase in interceptor sewer capacity, stormwater and wastewater separation, and multiple overflow treatment facilities. The plan also identified the future location for tertiary treatment upgrades at the existing RPWRF site. The final recommendations of this 1972 Action Plan included the addition of secondary treatment to the POTW, CSO treatment at five separate locations, and sewer separation in some areas. The control requirements recommended in this plan, made well before PCBs were sampled for or detected in the Spokane River, are the same measures being implemented by the City today. Attributing these costs to the presence of PCBs is extremely misleading and unsupportable.

3.2.2 1974 NPDES Permit

In February 1972, the State of Washington passed a bill requiring all POTWs to obtain a permit for the discharge of POTW effluent into waters of the State (1972 executive session 1, Chapter 140). In November 1973, the City submitted an application to discharge into the waters of the United States. After public notice and a hearing, the permit was granted on October 25, 1974 (NPDES Waste Discharge Permit WA-002447-3; Ecology, 1974). The permit required that the monthly average volume of effluent discharged daily should not exceed 35 MGD. It also required that records be maintained on all treatment plant bypasses, both total and partial. It further required that whenever a facility expansion or process modification required increased discharge, a new application should be submitted, and no changes undertaken until a new permit issued. The permit allowed bypasses without a new permit when necessary to avoid facility damage. No discharge limitations were established for PCBs.

3.2.3 1976 Metropolitan Spokane Region Water Resources Study

The 1976 water resources study for the City by the United States Army Corps of Engineers (USACE, 1976) documented deficiencies in the City's wastewater management system leading to violations of water quality standards:

1. *"Violation of water quality standards through operation of a primary STP which was deficient in removal of BOD, bacteria, and phosphorus.*
2. *Violation of water quality standards through combined sewage overflows both at the treatment plant and throughout the interceptor system*
3. *Excessive infiltration in certain areas of the collections system*
4. *Local street and basement flooding at various locations throughout the City due to a variety of causes including combined sewers, roots and restricted sewers and structurally failed sewers.*
5. *An unknown pollutional impact caused by the urban runoff component of the combined sewage flow."* (USACE, 1976, p. 49)

The plan acknowledged the potential impact of separation of stormwater and sanitary sewage and that this separation would have a potential impact on water quality from untreated stormwater runoff.

> "*One of the alternative methods to be analyzed in the City plan of study for correction of combined sewer overflow problems is the separation of storm and sanitary sewage. Where this is accomplished, there will be direct discharge of untreated urban runoff to the Spokane River. There will then be an unmet need to evaluate the potential impact of these urban runoff wastewaters to determine their impact on water quality*" (USACE, 1976, p. 50)

Treatment alternatives for the urban run-off (URO) were presented, which include the same types of structural stormwater management alternatives that the City presents in its green infrastructure alternatives in its Integrated Plan (CH2MHill, 2014b).

> "*These alternatives fall into three categories: storage, treatment, and percolation. Storage provides treatment in itself through sedimentation, but the most important function of storage is reduction of attenuation of the high peak flows characteristic of URO. Reduction of the high peaks reduces impact by spreading the pollutant load over a longer period of time, if released untreated, and greatly reduces the cost and increase the effectiveness of treatment. The large number of ways that can be used to create more storage are most effective if kept in mind*

> *during the early stages of system development. The lack of storage and storage opportunities in the City is going to make any approach to URO pollution reduction difficult and costly*." (USACE, 1976, p. 263)
>
> The report further recommends "*[M]inimizing the direct connections of impervious surfaces to the collection system to provide treater opportunities for pollutant reduction through overland flow, surface storage and percolation.*" (USACE, 1976, p. 263)

All of these assessments in 1976 occurred decades before PCBs were ever detected in the Spokane river.

3.2.4 1977 Facilities Planning Report for Overflow Abatement

The 1977 Facilities Planning Report for Overflow Abatement developed various structural alternatives to reduce the volume and frequency of CSO events to the Spokane River. The 1977 Plan estimated that in an average year, over 925 overflow events and over one billion gallons of untreated wastewater were discharged to the river (City, 2016a). The plan evaluated three scenarios for mitigation of CSO discharges, one of which was construction of CSO storage tanks. The City elected to adopt the less expensive CSO reduction alternative of separation of the stormwater and sewage system in the north side of the City (City, 2016a). The City selected this alternative despite its knowledge from the 1976 USACE report that stormwater separation would likely lead to required treatment of stormwater discharges in the future (USACE, 1976).

3.2.5 1979 USEPA Environmental Impact Statement

In 1979, the USEPA issued an environmental impact statement evaluating the potential ramifications of storm sewer separation on water quality in the river. They concluded that separation of the stormwater system would result in increased discharge of a wide range of constituents including TSS, oil, salts, metals, and pesticides. USEPA and Ecology encouraged the City to implement stormwater control measures, including diversion of storm flows to percolation/groundwater recharge basins to address these discharges. These are the very same measures the City is now implementing, 40 years later, and blaming on PCBs alone.

> "*There are insufficient data to analyze some of the other potentially harmful stormwater components such as oil, salts metals and pesticides. With an increase in untreated direct runoff, it is likely that more of these deleterious materials will reach the river. However, the city could mitigate this problem by implementing a variety of control practices for urban runoff. Screening of all stormwater outfalls,*

> *more vigorous street cleaning efforts and paving of dirt roads are logical first steps toward reducing stormwater discharge impacts on water quality. This can be combined with a variety of other actions including but not limited to the following: dry weather flushing of storm drain catchment basins, investigation of different deicing techniques, diversion of storm flows to percolation/groundwater recharge basins, tighter control over used oil disposal, and initiation of a public education program to keep toxic materials used at home out of the storm drain system.*
>
> *It is possible that there will eventually be federal or state treatment requirements for stormwater discharges, but at this time EPA and DOE are simply encouraging adoption of suitable control measures. If treatment requirements do become a reality, the separated stormwater and sanitary wastewater systems should facilitate treatment. Without implementation of control practices, stormwater discharges will carry an unnecessarily large amount of suspended solids, debris and a variety of chemical compounds into-the river; this will be especially true when storms follow an extended dry period.'*" (USEPA, 1979)

3.2.6 1979 Facility Planning Report for Overflow Abatement Update

The 1979 Facility Planning Report for Overflow Abatement Update amended the 1977 plan, identifying further areas for stormwater and wastewater separation, and included the proposed modification of the wastewater treatment plant (WWTP) to add secondary treatment as required by Ecology in 1972. The treatment goal was defined as advanced wastewater treatment providing >85% reduction in BOD and phosphorus removal and >90% suspended solids removal (Soltero et al., 1992). The plan for sewer separation was implemented throughout the 1980's and separating stormwater from CSOs resulted in an 86% reduction in annual CSO volume discharged (CH2MHill, 2014b).

3.2.7 1980 NPDES Permit

In November 1980, the RPWRF NPDES permit was updated. The permit required that the weekly average volume of effluent discharged daily should not exceed 50 MGD. It further placed effluent limitations on BOD, suspended solids, fecal coliform bacteria, pH and total phosphorus, requiring chemical phosphorus removal between June 1st and October 15th. No discharge limitations were established for PCBs. The permit further required that the City adjust their weir settings within their CSO system to increase sewage storage in the interceptor sewers and reduce the number and volume of CSO events (Ecology, 1980). This permit was amended and re-issued in September 1981 and May 1984.

3.2.8 1986 NPDES Permit

In September 1986, the RPWRF NPDES permit was updated. The permit required that the monthly average volume of effluent discharged daily should not exceed 44 MGD. It maintained effluent limitations on BOD, suspended solids, fecal coliform bacteria, pH, and seasonal reduction in total residual chlorine, total ammonia, mercury, silver, and phosphorus. No discharge limitations were established for PCBs. The permit continued to require chemical phosphorus removal between June 1st and October 15th. Limitations on ammonia in plant effluent were set for July through October (Ecology, 1986).

3.2.9 1992 NPDES Permit

The City was issued an updated individual NPDES permit for the RPWRF in April 1992 (Ecology, 1992). This permit required that a CSO reduction plan be prepared and submitted by November 1st, 1994. Under this permit, the City had to meet discharge limits for BOD, TSS, pH, fecal coliform bacteria, total residual chlorine, total ammonia, minimum seasonal phosphorus removal, total mercury, and total recoverable silver. No discharge limitations were set for PCBs. The 1992 permit also required the City to develop a Phase 2 CSO Reduction Plan, with the end goal of reducing overflows to "*no more than one discharge per outfall per year*" and to submit that plan by November 1st , 2004 (Ecology, 1992).

3.2.10 1992/2010 Phosphorus/Dissolved Oxygen Total Maximum Daily Load

Elevated levels of phosphorus and nitrates in surface water serve as nutrient sources that can result in blooms of algae (Carpenter et al., 1998). These algal blooms subsequently die, causing depletion of dissolved oxygen (DO) levels resulting in fish kills. In the 1970's, algal blooms were present in Lake Spokane (also known as Long Lake), caused by elevated levels of phosphorus in the Spokane River from nutrients coming from the predecessor treatment plant to the City's RPWRF (Ecology, 2004). At that time, the recommendation to the Washington State Water Pollution Control Commission was to reduce BOD, nutrient concentrations, and coliform levels.

However, algal blooms and low DO levels remained problematic through the 1970s and 1980s. This resulted in the development of a phosphorus management plan in 1989, which was later expanded into a total phosphorus TMDL analysis in 1992 (Ecology, 2010b). Subsequent and ongoing violations of DO limits led to the inclusion of several segments of the Spokane River on the 1996, 1998, 2004, 2008, 2012, and 2015 303(d) lists for low DO levels (Ecology, 2010b). By 2004, it was clear that the phosphorus TMDL was inadequate as it failed to address differences sufficiently between the Idaho and Washington point-source dischargers, and it did not account for Avista's Long Lake Dam

(Ecology, 2010b). The current DO TMDL was established in 2010. This TMDL further reduced the total phosphorus load allocations and these allocations have been subsequently incorporated into the NPDES permits for dischargers into the Spokane River. The objective of the new TMDL is for dischargers to meet their respective phosphorus discharge allocations (i.e., each discharger is allocated a maximum daily amount that can be discharged) by 2020 (Ecology, 2010b).

3.2.11 1994 Combined Sewer Overflow Reduction Plan

The 1994 CSO Reduction Plan established a 20-year schedule for achieving the NPDES permit requirement of one overflow event per outfall per year based on a 20-year running average, through construction of concrete stormwater storage tanks throughout the City. An iterative approach was proposed for constructing new control facilities, monitoring the results, and using that data to plan the next phase of controls. In 1994, it was estimated that an average of 467 overflow events occurred annually, resulting in nearly 80 million gallons of untreated sewage discharged to the river each year (City, 2016a). In addition to storage tanks, this plan recommended the adoption of stormwater BMPs to reduce CSO discharges related to storm events. The evaluation of CSO pollutant load in the 1994 plan does not include PCBs in its analysis (Bovay, 1994). However, these are the very same BMPs the City now blames on PCBs alone:

> "*There are a wide variety of storm water and sanitary sewer flow reduction and management techniques that can be categorized as best management practices (BMPs). Best management practices include street surface cleaning, catch basin maintenance, combined and storm sewer flushing, sewer rehabilitation for inflow and infiltration reduction, water use reduction, grass bio-filter retention swales, and wastewater ordinances directed at source control. All of these practices constitute source controls to some extent, with a common principle of reducing pollutant accumulation on impervious surfaces in the drainage basin, or in portions of the collection system itself to reduce pollutant loadings from untreated CSO discharges during storm events.*" (Bovay, 1994, p.5-1)

These BMP practices are now called Green Infrastructure (GI) by the City and were adopted in its 2013 CSO Plan Amendment and 2014 Integrated Clean Water Plan (CH2MHill, 2014a, CH2MHill, 2014b). However, they were first proposed in the City's 1994 CSO Reduction Plan (Bovay, 1994):

> "*City-wide inflow reduction efforts include requiring new development to retain the first half-inch of storm water runoff in grassy swales…Since inflow contributes to peak storm water flow, reduction of inflow in combined sewered areas reduces*

> *the frequency and volume of overflows. Future inflow reduction efforts might be focused in combined sewered areas as a best management practice to reduce overflow frequency and volume.*" (Bovay, 1994, p. 5-4)

> "*This technique can be used to prevent storm runoff from reaching combined sewers, by infiltrating into the ground through a thick, well tended grass sod layer. Grass swales could reduce storm flows during the growing season significantly by retaining storm water either on the site or in a lot close to the area of rainfall.*" (Bovay, 1994, p. 5-4)

3.2.12 1995 Stormwater Permitting

Ecology started a permit program for MS4s in 1995, beginning with three general stormwater discharge permits in Western Washington. In 2007, Phase I General Permits were issued by Ecology to Clark, King, Pierce and Snohomish Counties and the cities of Seattle and Tacoma (incorporated cities with a population over 100,000 and unincorporated counties with populations of more than 250,000 according to the 1990 census); Phase II General Permits were issued in the same year to all regulated small municipal separate storm sewer systems in Eastern and Western Washington, respectively, including the City of Spokane (Ecology, 2011b). No discharge limitations were established for PCBs.

In 1998, Ecology established TMDL limits for cadmium, lead, and zinc for dischargers to the Spokane River (Ecology, 1998). Based on these TMDL requirements, discharges from the City's RPWRF were required to meet numeric effluent limitations for these metals as part of its current NPDES permit (Ecology, 2011a). Soil and sediment, affected by over 100 years of metals mining in Idaho, have been transported downstream into the Spokane River (USEPA, 2015). The Bunker Hill Superfund Site is the largest historical source of heavy metals discharged to the Idaho sub-basin (Ecology, 1998). Material from the Bunker Hill Superfund Site, other upstream mining facilities, CSOs, and urban stormwater runoff contribute to repeated exceedances of water quality standards (Ecology, 1998) for certain metals.

3.2.13 2000 NPDES Permit

When the 1992 NPDES permit expired, the City operated on an extension of the same permit until Ecology issued the 2000 NPDES permit (Ecology, 2000a). The 2000 permit expanded the discharge limitations, and adding limits for cadmium, lead, and zinc (Ecology, 2000b). No discharge limitations were established for PCBs. The permit specifies that "*No authorization is given by this permit for discharge from a CSO that causes adverse impacts that threaten characteristic uses of the receiving water as*

identified in the Water Quality Standards" (Ecology, 2000b, p. 34). The permit established a CSO Compliance Schedule, which incorporated a deadline of December 31, 2017 for meeting final State and Federal requirements of one CSO event per outfall per year and added that this discharge standard must be based on a 20-year moving average of discharge events for each outfall.

The 2000 permit was extended past its original 2005 expiration based on Ecology's desire to delay implementation of a new permit prior to the approval of the Spokane River DO TMDL, which they had hoped to implement by 2006 (Ecology, 2005). This DO TMDL was not finalized until 2010 (Ecology, 2010b), and the City continued to operate under the 2000 permit throughout that time. The history of effluent limitations from the RPWRF is presented in Exhibit 3-1 below.

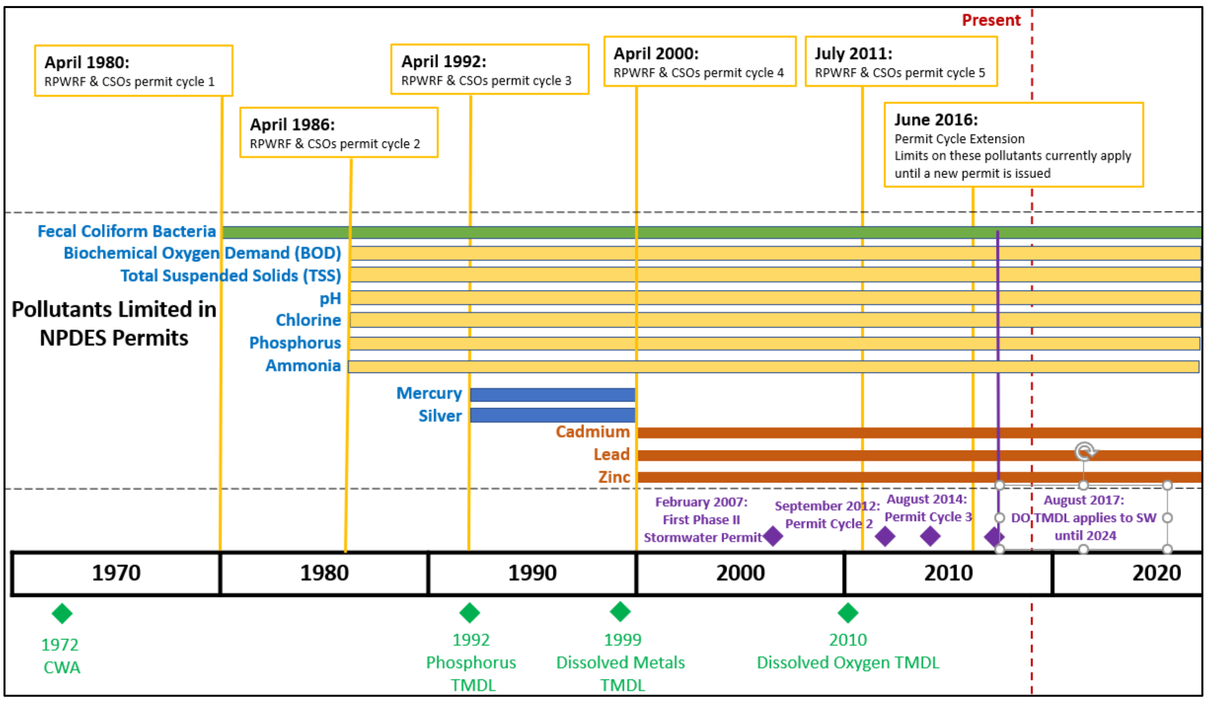


Exhibit 3-1: History of RPWRF NPDES Permit Effluent Limitations
Source: Ecology, 1980; 1986; 1992; 2000a; 2011a

3.2.14 2005 Combined Sewer Overflow Reduction System Wide Alternative Report

In 2005, the City amended its 1994 CSO Reduction Plan, updating its computational model for predicting flow and incorporating data from growth of the City. The plan evaluated a number of alternative CSO reduction strategies and called for CSO compliance to be based on a 5-year moving average (City, 2005b). Based on the report recommendations, the City constructed a total of six CSO control facilities for outfalls 2, 10, 16, 19, 38, and 42 (City, 2005b). PCBs are not mentioned in this report.

3.2.15 2008 Sierra Club Lawsuit

The City's ongoing CSO discharges were the subject of a lawsuit from the Sierra Club in 2008, which was settled through the development of the City's CSO reduction program, which was described by the Community Indicators of Spokane Website:

> "*The good news for the Spokane River, and those who enjoy it, is that in 2008, the City of Spokane and the Sierra Club settled on an agreement that required the City to make immediate improvements to the combined sewer systems through a project called the CSO Reduction Program. Once completed, the improvements will reduce the number of wet weather CSO events and virtually eliminate dry weather CSO events. The settlement prevented a potential lawsuit that the Sierra Club would have filed against the City under the federal Clean Water Act because of the repeated illegal discharges of raw/untreated sewage into the Spokane River and Latah Creek during CSO events.*
>
> *The process to reduce the overall number of CSO events and to modernize the City's aging and inadequate combined sewer system began in the 1980's but has recently gained momentum, partially as a result of the illegality of the overflows, but also because of the City of Spokane's Six-Year Comprehensive Sewer Program that was implemented in 2006*" [5]

3.2.16 2011 NPDES permit

The City's NPDES permit for the RPWRF was re-issued in June 2011 (Ecology, 2011a). This permit has been extended and is the permit under which the facility currently operates. Under this permit, the City is required to meet discharge limits for BOD, TSS, pH, fecal coliform bacteria, total residual chlorine, total ammonia, phosphorus, cadmium, lead, and zinc. More stringent seasonal discharge limitations for phosphorus still apply. The City was required to prepare and submit a mercury abatement and control plan by February 2016. No discharge limitations are set for PCBs. However, discharge monitoring for toxics was established (2,3,7,8 TCDD[6], PCBs, and PBDE[7]). The 2011 permit required the City to complete the implementation of its CSO Control Plan by December 31, 2017. Furthermore, the City was required to submit verification that the next level treatment for phosphorus removal in the critical season are installed and

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[5] http://www.spokanetrends.org/graph.cfm?cat_id=4&sub_cat_id=1&ind_id=11
[6] 2,3,7,8-tetrachlorobenzodioxin
[7] polybrominatded diphenyl ether

continuously operating by 1 March 2018. The City has not met either of these deadlines (Ecology, 2017a).

3.2.17 2013 Combined Sewer Overflow Reduction Plan Amendment

By 2014, the City had still not met its 1994 20-year CSO control compliance schedule. Updates to the City's RPWRF NPDES permit in 2011 allowed for more time to achieve CSO control, defined as one CSO event per outfall per year, on a 20-year moving average, and extended the compliance deadline to December 31st, 2017. The 2013 CSO Reduction Plan Amendment revised the stormwater modeling inputs using smaller design storms and eliminating snowmelt from control volume estimates. This design change revised many underlying assumptions for tank volume requirements, reducing the design storm each of the CSO basins. This resulted in a nearly 75% reduction in the total control volume for the planned CSO tanks from 58 million gallons to 15 million gallons (CH2MHill, 2014a). BMPs that were first introduced in the 1994 CSO reduction plan were identified as GI in this plan and were proposed as risk reduction strategies to mitigate CSO events.

3.2.18 2014 Integrated Clean Water Plan

The 2014 Integrated Clean Water Plan (CH2MHill, 2014b; Integrated Plan) was voluntarily developed by the City to prioritize projects addressing stormwater, CSO, and wastewater treatment by identifying projects which would have the largest effect in reducing overall impacts on the Spokane River, while reducing the City's capital and operating costs (Condon, 2019). The recommended control action combined CSO storage, Green Infrastructure BMPs, Cochran Basin stormwater control, and Non-Critical season membrane filtration. This alternative was estimated to remove the following loads from the Spokane River (Exhibit 3-2):

Constituent	Amount Removed
Total Phosphorus	121,900 pounds/year
Fecal Coliform	897,000 billion colony forming units/year
Total Suspended Solids	1,455,000 pounds/year
Total/Dissolved Zinc	1,070 pounds/year
PCBs	0.064 pounds/year

Exhibit 3-2: Estimated Mass Removal for Integrated Plan Alternative 3
Source: CH2MHill, 2014b

The Integrated Plan considered the relative benefit of reduction of all constituents in stormwater. In each case, the selected alternative provided the most removal of all constituents of concern, and consequently the Integrated Plan recommendations would

have been no different if PCBs had never been invented. It should be noted that PCBs were chosen to represent a class of toxic organic constituents that require attention.

3.2.19 Current City of Spokane Stormwater System

Currently, less than half of the City is serviced by the MS4, (Exhibit 3-3) (City, 2016c) where the wastewater and stormwater collection systems are not combined. The MS4 separately conveys only stormwater away from streets, parking lots, and other impervious surfaces, either into areas of evaporation and infiltration, into Underground Injection Control (UIC) drywells, or into separate storm drain conveyances, which ultimately discharge into the Spokane River or Latah Creek. The remaining 46% of the City is serviced by the historical combined sewer system, which carries a combined flow of wastewater and stormwater flow to the RPWRF. As of 2014, the City maintained 471 miles of separated sanitary sewers, 400 miles of combined sewers and 366 miles of MS4 stormwater piping (CH2MHill, 2014b). During periods of heavy rainfall or snowmelt, the capacity of the combined sewer system can be overwhelmed, triggering CSO event, discharging untreated sewage directly to the river in order to prevent damage to the wastewater treatment system and backflow of untreated sewage into the City.

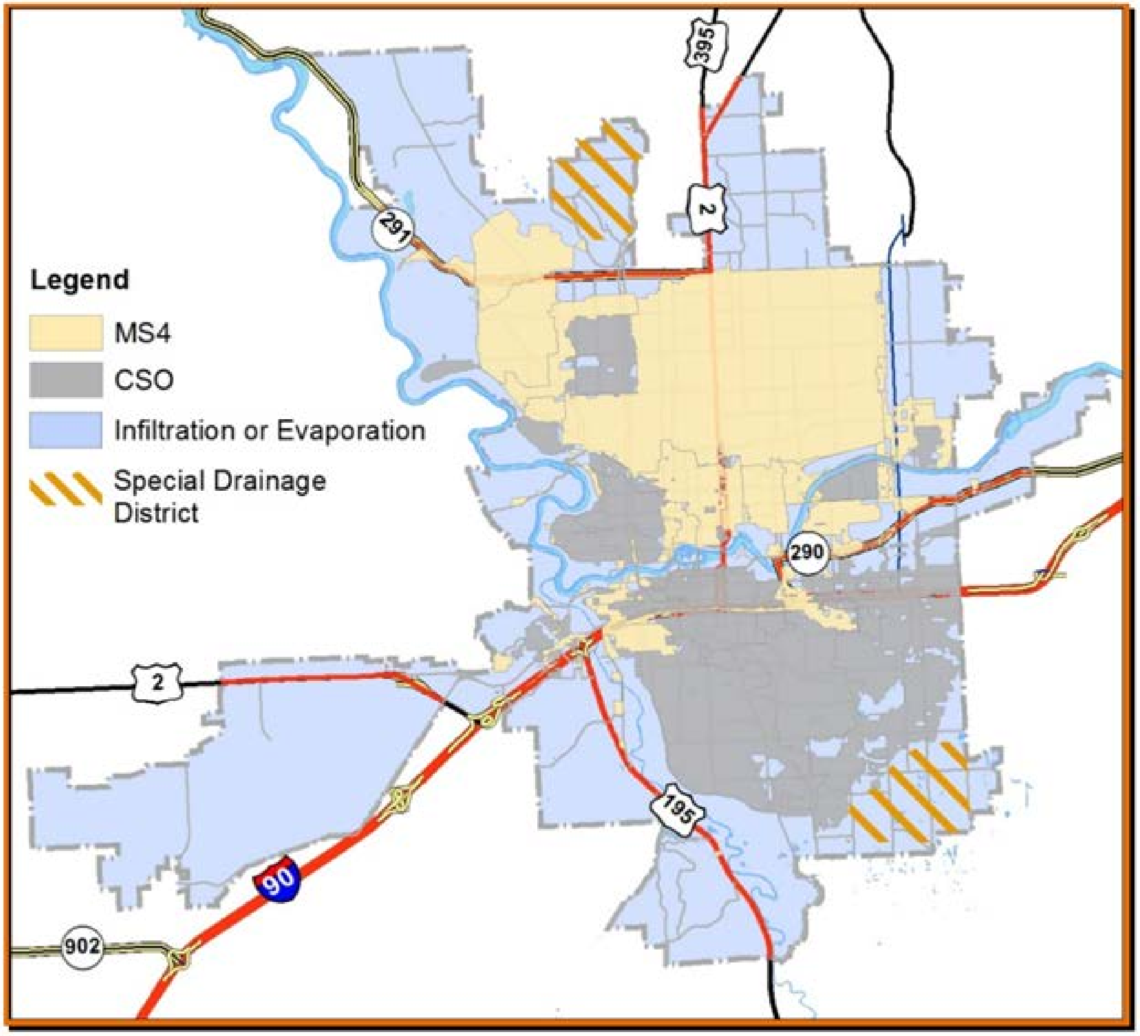


Exhibit 3-3: City CSO and MS4 Stormwater Infrastructure
Source: City, 2016c

Since 1972, the City has gradually implemented CSO reduction plans to reduce the frequency and volume of sewage discharges to local waterways (CH2MHill, 2014b) which is required under the CWA. As of the most recent report (City, 2019b) the City still is not in compliance with CSO control requirements. A summary of City CSO compliance and planned controls for the CSO outfalls since 2000 is presented in Exhibit 3-4. A map of MS4 and CSO basins are presented as Exhibit 3-5 and Exhibit 3-6.

EXHIBIT 3-4
Summary of CSO Compliance and Controls

CSO Outfall No.	Receiving Water	Reported Number of Overflows per Year																			Average Annual Overflow Frequency	Compliant with NPDES Permit since last modification	Controlled Since	Notes
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018				
002	Spokane River	0	3	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.0	Yes	2003	Control facility operational since 2003
003	Spokane River	0	8	16	0	Outfall Eliminated (2003)															NA	--	--	--
006	Spokane River	3	17	27	24	32	23	35	23	21	27	30	21	30	22	28	17	2	2	0	20.2	No	--	Final regulator setting not in place
007	Spokane River	NM	8	10	14	11	15	18	9	6	13	11	5	7	3	6	6	3	1	4	8.3	No	--	Final regulator setting not in place
010/012	Spokane River	0	8	11	10	7	13	17	8	6	12	13	8	1	0	0	0	0	0	0	6.0	Yes	2012	
010/012	Spokane River	10	23	29	34	31	26	39	25	22	32	33	15	23	15	19	11	19	3	0	21.5	Yes	2018	
014	Spokane River	NM	NM	11	20	11	21	36	17	16	18	1	0	3	0	2	5	6	4	3	10.2	No		Weird modified in 2009; control facility constructed in 2018
015	Spokane River	1	5	9	11	10	14	17	5	9	12	2	3	2	0	2	0	0	0	0	5.4	No		Weird modified in 2009; control facility constructed in 2018
016	Spokane River	NM	0	6	11	9	14	16	5	0	0	0	0	0	0	0	0	0	0	0	3.4	Yes	2008	Control facility operational since 2007
019	Latah Creek	NM	0	0	0	1	0	1	2	0	1	0	0	0	0	0	0	0	0	0	0.3	Yes	2011	Control facility operational since 2010
020	Latah Creek	NM	NM	NM	NM	1	0	0	0	0	1	0	0	2	0	2	1	0	0	0	0.5	Yes	2016	Control facility operational since 2016
022	Spokane River	0	1	5	2	3	1	1	1	2	0	0	0	0	0	1	1	0	0	0	0.9	Yes	2009	Influenced by CSO 25
023	Spokane River	3	16	20	20	17	18	28	18	16	17	16	0	12	1	7	6	5	3	4	11.9	No		Control facility constructed in 2018
024	Spokane River	5	15	33	33	19	27	31	16	15	20	28	22	29	18	24	12	17	28	12	21.3	No		Control facility constructed in 2018
025	Spokane River	NM	0	5	44	19	18	31	15	17	20	20	16	22	15	20	10	18	15	7	17.3	No		Control facility constructed in 2018
026	Spokane River	4	16	20	24	20	20	33	16	20	27	30	21	33	21	28	16	26	32	34	23.2	No		Control facility construction planned for 2019
033	Spokane River	7	34	38	38	22	36	33	21	14	24	25	19	29	18	25	15	14	17	5	22.8	No	--	Control facility constructed in 2018
034	Spokane River	2	15	18	18	19	14	27	11	16	24	17	17	24	21	22	12	15	25	9	17.2	No	--	CSO 34-1 control facility planned for 2019
038	Spokane River	1	9	10	14	12	6	8	7	4	14	16	3	17	0	0	0	0	0	0	6.4	Yes	2013	
039	Spokane River	1	3	2	5	5	9	4	3	2	4	8	1	2	Outfall Eliminated (2012)						NA	--	--	
040	Spokane River	5	17	19	21	17	9	6	4	4	6	6	1	0							NA	--	--	
041	Spokane River	NM	0	9	10	12	12	13	7	7	13	22	13	15	12	17	11	16	13	0	11.2	Yes	2018	
042	Spokane River	0	1	0	0	0	10	3	0	2	0	0	0	0	0	0	0	0	0	0	0.8	Yes	2009	
Total CSO events per year		**42**	**199**	**314**	**353**	**278**	**306**	**397**	**213**	**199**	**285**	**278**	**165**	**251**	**146**	**203**	**123**	**141**	**143**	**78**	**224.22**			

Notes:

CSO - Combined sewer overflow

NM - Not measured

N/A - Not applicable

NPDES - National Pollutant Discharge Elimination System

Reference:

City, 2019b. Combined Sewer Overflow Annual Report - 2018. 30 August.

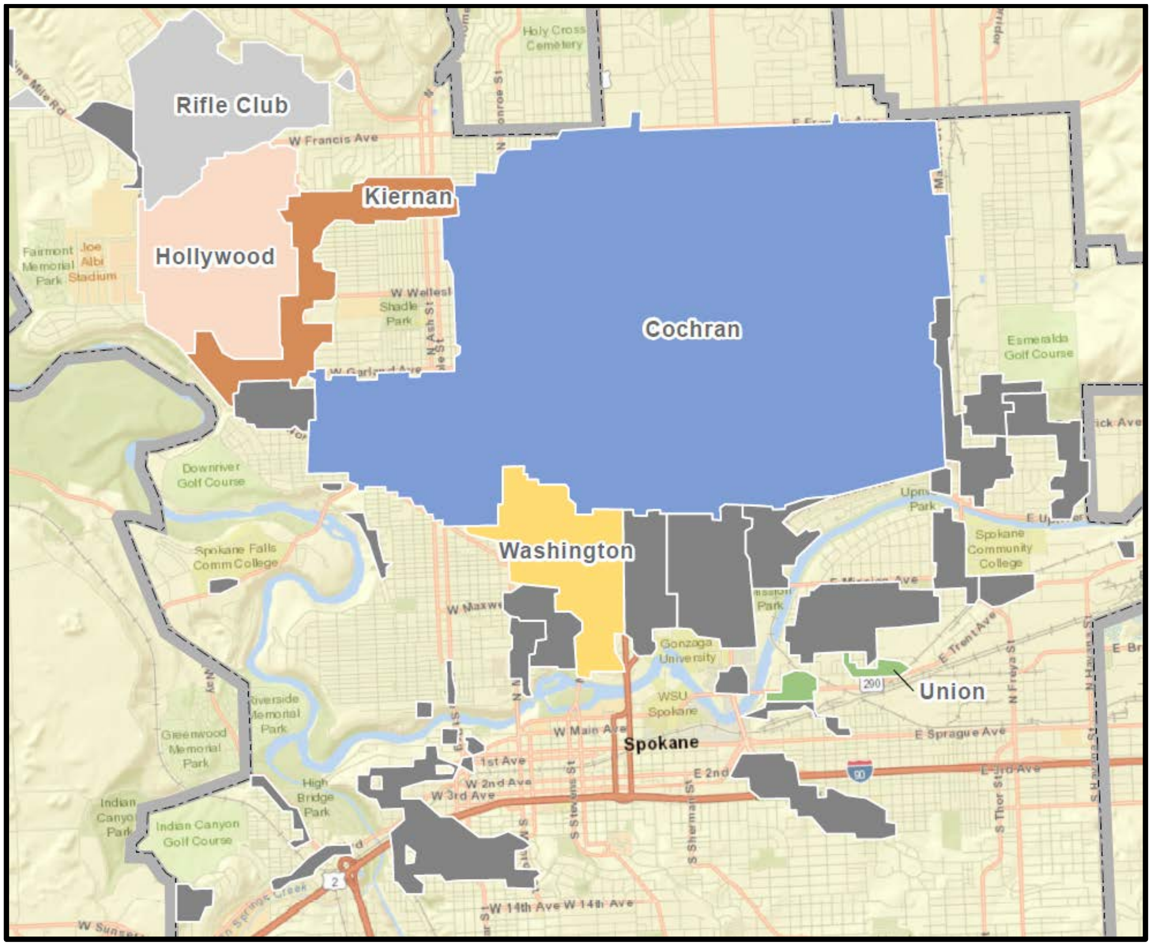
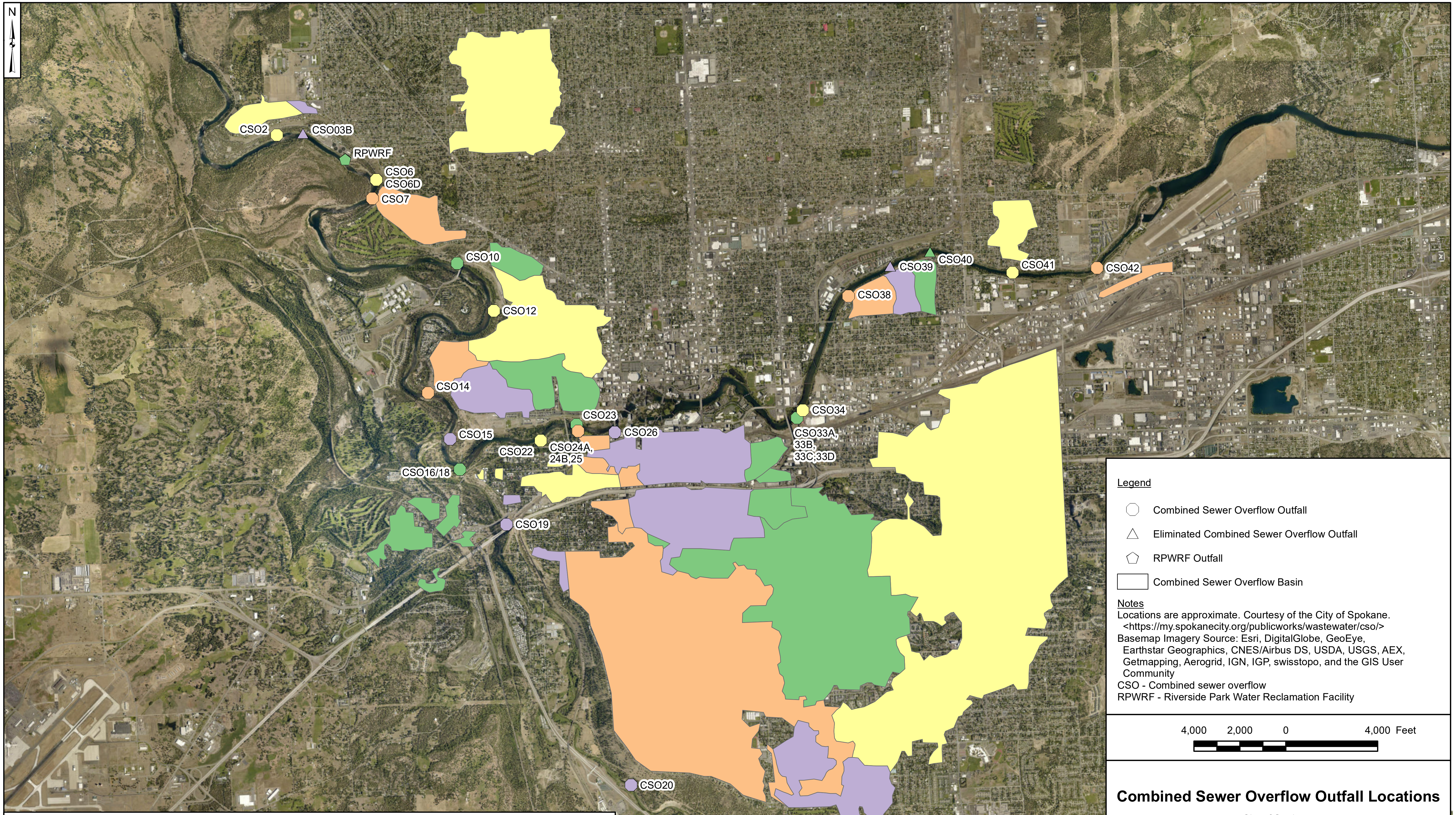


Exhibit 3-5: Major Spokane separated stormwater basins (smaller basins shown in gray)
(source: adapted from City, 2014b)

At the end of 2018, there were 19 CSO outfalls remaining within the City's combined sewer collection system (City, 2019b). As of December 2017, eight of the 20 outfalls identified in the 2013 CSO Plan Amendment have been addressed through implementation of CSO storage facilities with the remaining outfall controls still in the design or construction phase (CH2MHill, 2014a; City, 2017c). Since the year 2000, the City has discharged over a billion gallons of blended stormwater and untreated sewage from their CSO outfalls (City, 2001; City, 2019b).

The City's delay in implementing basic wastewater treatment practices, stormwater BMPs recommended since 1976, and a parallel delay in the installation of infrastructure upgrades required to control subsequent excessive CSO discharges, contributed to the historical and continuing discharge of a wide range of organic and inorganic constituents to the Spokane River that the City is still working to resolve. The costs that the City is presently incurring for upgrades to their stormwater, CSO and wastewater treatment



Legend

- Combined Sewer Overflow Outfall
- Eliminated Combined Sewer Overflow Outfall
- RPWRF Outfall
- Combined Sewer Overflow Basin

Notes

Locations are approximate. Courtesy of the City of Spokane.
<https://my.spokanecity.org/publicworks/wastewater/cso/>
Basemap Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
CSO - Combined sewer overflow
RPWRF - Riverside Park Water Reclamation Facility

4,000 2,000 0 4,000 Feet

Combined Sewer Overflow Outfall Locations

City of Spokane

Geosyntec consultants

Guelph | November 2019

Exhibit 3-6

References:
- CH2MHill, 2014b. City of Spokane Integrated Clean Water Plan FINAL. December.
- City of Spokane, 2015f. City of Spokane Combined Sewer Overflow (CSO) Annual Report Calendar Year 2014. 1 October.

systems are not due to the presence of PCBs but are required to meet their basic wastewater permit conditions for CSO control and phosphorus removal as mandated by their permit requirements under the CWA, that it has delayed for decades.

4. OPINION 3: THE ALLEGED DAMAGES THAT THE CITY ATTRIBUTES TO PCBS ARE IN FACT RELATED TO LONG OVERDUE UPGRADES TO THE CITY'S STORMWATER AND WASTEWATER SYSTEMS.

The City's alleged damage claims for long overdue stormwater and wastewater system upgrades including GI are related to the City's requirements to upgrade aging infrastructure and to meet its regulatory obligations under the CWA regardless of the absence or presence of PCBs in the Spokane River. As discussed in Opinion 2, the City has continued to delay implementation of long overdue and essential stormwater (MS4) systems, combined sewer systems, and wastewater treatment plant upgrades. These upgrades were needed to support its economic and population growth and were planned before PCBs were first discovered in the Spokane River in 1989[8] (City 30(b)(6) Davis, 2019a, 38:4-15). Furthermore, the City has designed CSO control systems that are inadequate to reduce stormwater volume being discharged to the City's CSS as described below in Section 4.1.2. The City has admitted that the GI upgrades for which the City claims costs, are in fact a 'safety net' to accommodate excess stormwater volume to bring their CSO system into compliance and have nothing to do with PCBs (City 30(b)(6) Davis, 2019b, 271: 3-25[9]; 272: 1-3[10]).

4.1 History of the City's delay in CSO mitigation

As discussed in Opinion 1, the City's sewage discharges to the river have been a known concern since the early 1900's. Since that time, the City has repeatedly delayed managing and reducing sewage discharges through CSOs. In the 1960's there were as many as 140 overflow events per year (Soltero et al., 1990). In 1972, the average total CSO volume was estimated at approximately 740 million gallons discharged each year (Esvelt &

---

[8] Q: What I'm saying is planning for the construction of these CSO tanks --
A. Yes.
Q. -- which we've already established in 1972 --
A. Okay.
Q. -- and the construction of MS4 basins, which we've established at 1980 or earlier --
A. Okay.
Q. -- that occurred before PCBs were detected in the Spokane River. Is that correct?
A. Yes.

[9] Q: So on the next page, the second paragraph down, it identifies – the sentence reads: "The City has prepared a variety of 'safety outs' that can be implemented if future flow monitoring data indicate that a CSO outfall remains out of compliance with the CSO performance measure." Correct?
A: Yes.

[10] Q: And one of those "safety outs" is to implement green infrastructure where feasible to reduce the volume of stormwater runoffs sent to the combined sewer system and ultimately, to Riverside Park Waste Water Recycling Facility, the RPWRF, correct?
A: Yes. It's one of those – one of the alternatives.

Saxon and Bovay Engineers, 1972, Table X-A). In 1979, USEPA noted "*untreated sewage enters the Spokane River with almost every rainstorm or snowmelt*" due to CSOs (USEPA, 1979, p. 1). In 1983, the City initiated the first of two phases of a sewer separation program and completed phase one in 1989 which reduced the total annual CSO volume by 491 million gallons (City, 1994).

The City has delayed upgrades in their stormwater management systems when judged against peer cities. The city of Tacoma is a relevant point of comparison of wastewater management practices in Washington, as it is relatively comparable in area and population size to Spokane. When Tacoma also faced increasing CSO events to the Bay in the 1950s, it began a major endeavor of separating surface water from wastewater in the 1950's to decrease the loading on its treatment systems. Tacoma had completed approximately 90% of a sewer separation program to address CSO events by 1966, approximately 17 years before Spokane began implementation of its sewer separation program (Melosi, 2000). By 1993, Tacoma had disconnected all storm drains from the sewer system (City of Tacoma, 2017). In addition, in 1995, Tacoma also commenced an aggressive inflow and infiltration program to reduce the quantity of wastewater that required treatment[11]. To my knowledge, Tacoma does not claim that these investments are due to the presence of PCBs in their waste streams.

For comparison, the City amended its 1994 CSO Reduction Plan in 2005 and constructed a total of six CSO control facilities, over ten years after they were initially proposed. CSO control facilities continue to be built approximately 25 years after the issuance of the 1994 CSO Reduction Plan, with the City yet to meet its NPDES permit required compliance schedule of one CSO per year per outfall (Exhibit 3-4).

Prior to the construction of the Spokane POTW, the City's wastewater from the combined sewer system was discharged directly to the Spokane River causing severe water quality degradation in the river. Although the Washington State Department of Health twice ordered the City to prevent discharge of wastewater into the Spokane River in 1909 and in the 1920's (Soltero et al., 1992), a POTW offering even primary treatment was not operational for the City until 1958 (Reisdorph and Wilson, 1963). As discussed in Opinion 1 and further substantiated below, the construction of the POTW and subsequent upgrades continually lagged years behind best management practices for wastewater treatment systems both locally and nationally.

[11]https://www.cityoftacoma.org/government/city_departments/environmentalservices/wastewater/wastewatersystem/tacomas_wastewater_history

Approximately 58% of U.S. cities with populations of 100,000 and located on rivers similar in size to the Spokane River, provided some form of sewage treatment by 1933 (Pearse, Greely, & Hansen, 1933); the City of Spokane provided no treatment for another quarter century. Approximately 63% of the sewered population of the United States was served by a treatment system in 1945. By 1957 this had increased to 78% (Melosi, 2000).

The primary treatment system at the RPWRF did not commence operation until 1958, placing it well into the lower quartile of cities to implement primary treatment. By 1962, approximately half of the entire nation's sewered population was served by POTW's providing secondary treatment (Exhibit 4-1).

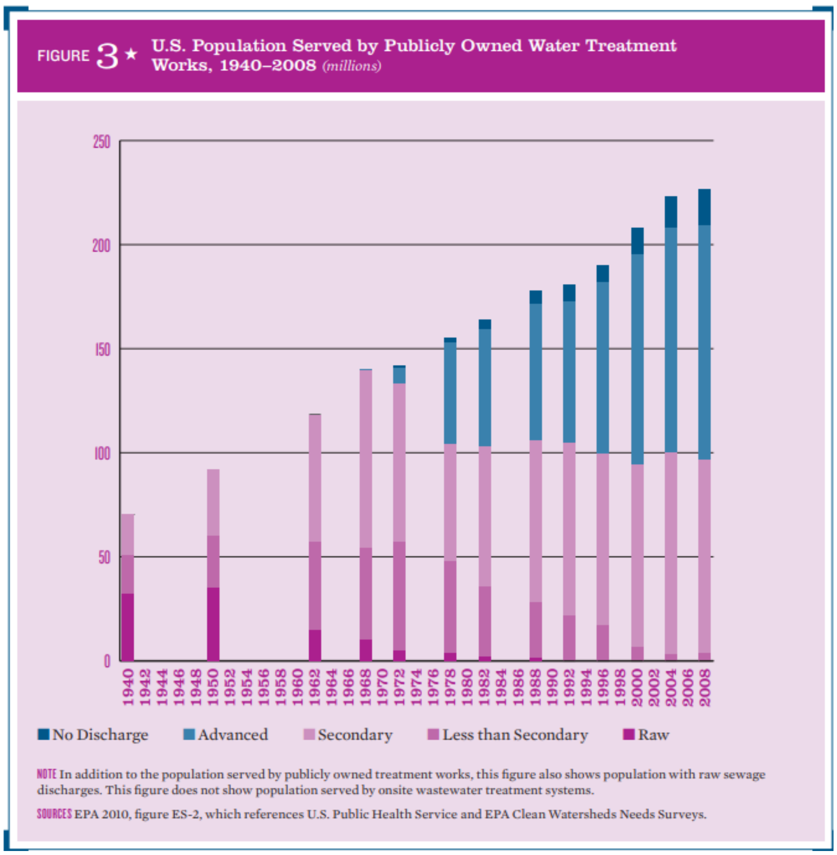


Exhibit 4-1: U.S. Population Served by POTWs by Treatment Type, 1940-2008.
Source: ASCE, 2011

In 1970, twelve years after the RPWRF became operational, the Water Pollution Control Commission forced the City to upgrade its wastewater treatment plant. This was the first such order issued to a municipality by the Water Pollution Control Commission (Ecology, 1970). Completion of the secondary treatment system was originally required by the end of 1972 but was not completed until 1977.

The city of Coeur d'Alene also provides a relevant local point of comparison. Coeur d'Alene installed its first sanitary sewer pipes in 1906 that conveyed sewerage from the city to one outfall at the Spokane River downstream of Lake Coeur d'Alene. Even during this time, it was understood that discharging untreated wastewater to the river would negatively affect the water quality of the river, and various officials of the City of Spokane were opposed to Coeur d'Alene's proposed sewer system (Fredrickson, 2014). While Spokane officials were generally opposed to new upstream sewer discharge to the river, the City itself continued to discharge raw sewage directly to the Spokane River for another fifty years, until the RPWRF with only a primary wastewater treatment process was commissioned in 1958. Although the population of Coeur d'Alene was approximately twelve times smaller than Spokane (with a population in 1940 of approximately 10,000, compared to the Spokane's 122,000; Census, 1940), it was years ahead in implementing centralized sewage treatment. In comparison, Spokane's RPWRF was commissioned approximately 20 years later, to serve a larger population, and offered only primary treatment. Secondary treatment upgrades at the RPWRF were only completed in 1977, 38 years after Coeur d'Alene had opened their secondary POTW ("SRSP Historic Timeline," 2018).

> *"The Coeur d'Alene wastewater treatment plant was first commissioned in 1939. It was initially a secondary plant. The primary portion consisted of headworks with screening and disinfection with chlorine; and a flocculator followed by a single primary clarifier. The secondary portion consisted of a rock-media trickling filter followed by a secondary clarifier. The final effluent was not initially chlorinated for disinfection before being discharged to the Spokane River through an open pipe that ended about 200 feet from shore. There was separate grit removal in the flocculator. There was a natural or digester gas fired incinerator to dispose of the screenings. Primary and secondary sludge was sent to two digesters; first to a primary and then into the secondary. Digested sludge then went to sludge-drying beds. Final biosolids (sludge) disposal was achieved by making the product available to the citizens and land application on city property*" (Fredrickson, 2014; p. 20).

Additionally, in the 1972 Action Plan, the City has admitted that it was contemplating implementation of tertiary treatment (NLT) at the RPWRF focused on phosphorus removal and identified geographical space for a tertiary treatment system at the current

RPWRF facility, much earlier than the initial detection of PCBs in the wastewater system (City 30(b)(6), Hendron, 2019, 89: 3-18[12]; City 30(b)(6), Hendron, 2019, 90: 5-23).[13]

4.1.1 Green Infrastructure for CSO Control

Several of the GI projects claimed by the City as stormwater response actions are located within CSO basins. These projects were part of the City's engineering design to reduce the number of CSO overflow events, as required by the City's NPDES permit (Ecology, 2011a). In fact, the City concedes that it planned to implement MS4 BMPs before PCBs

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[12] In 1972, the City was contemplating tertiary treatment focused on phosphorous removal before PCBs were ever detected
Q: And it says: The installation of tertiary chemical precipitation process following biological treatment could achieve phosphorous removal; and it goes on from there, correct?
A: Yes, it does.
Q: And that's – tertiary care is the next level treatment, correct?
A: Correct
Q: And so already in 1972, the city was contemplating a next-level treatment focused on phosphorous removal, correct?
A: Yes.
Q: And again, this was before PCBs were detected in the system?
A: Correct.

[13] Q: Near the back of this document, there is a diagram of the Riverside facility, correct?
A: Yes.
Q: And it depicts primary treatment?
A: It does.
Q: And it depicts what will be, in four- or five- year's time, secondary treatment facilities?
A: Conceptually, yes.
Q: Yeah, conceptually, right. And then on the right, there's a geographical space identified for next-level treatment, correct?
A: For – yes, what became next level treatment.
Q: Okay. And that's the facility being constructed right now?
A: That is correct.

were ever detected in the stormwater (City 30(b)(6), Hendron, 2019, 173: 16-22[14]). In 1979, the USEPA recommended installation of infiltration facilities that the City is now constructing to reduce CSO discharges (City 30(b)(6), Hendron, 2019, 138[15]). The City's own 1994 CSO Reduction Plan recommended similar MS4 improvements to reduce CSOs and made no mention of PCBs in the Plan.

4.1.2 GI is required due to City's CSO control tank size reduction

The City has admitted that GI is a key component to achieve long-term compliance with NPDES permit required CSO performance measures (City 30(b)(6), Davis, 2019b, 263: 3-16[16]) and as noted above that GI is intended to provide a 'safety net' in the event that CSO discharges exceed the NPDES permit required limit. Over the years, the City has gone through multiple iterations of designs to develop CSO mitigation projects which will meet their NPDES permit criterion of no more than one discharge per outfall per year, over a 20-year averaging period. The underlying assumptions used for CSO storage

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[14] Q: Yeah. These are the same sorts of best management practices in terms of street cleaning, surface cleaning, catch basin maintenance, and storm sewer flushing, sewer rehabilitation for inflow and infiltration reduction, grass biofilter retention swales, et cetera?
A: The last three, I believe, are relatively new water use reduction being water conservation to reduce flows. Grass biofilter, I think, was a step up from what they called percolation previously. And wastewater ordinances directed at source control, I think, is new in this plan.
Q: Okay. These are the sorts of things that you'd be doing as a city, correct?
A: Correct.
Q: And you started doing them before PCBs were ever detected in the stormwater, correct?
A: Correct.

[15] A: That would be what's equivalent to an infiltration facility where the water is diverted out of the street into a depressed area to allow it to soak into the ground.
Q: That's the sort of thing you're doing now.
A: Yes.
Q: Okay. That's the very thing the EPA is recommending in 1979?
A: Yes.
Q: Am I correct that this was before PCBs were ever detected in stormwater in the city?
A: I believe so, yes.

[16] Green Infrastructure is a key component to achieve long-term compliance with the CSO performance measure.
Q: "As discussed in Chapter 4, GI to intercept stormwater runoff before it ends up in the combined sewer system is a key component of the City's efforts to achieve long-term compliance with CSO performance measure" – "with the CSO performance measure." Did I read that correctly?
A: Yes.
Q: And do you agree with that?
A: Yes.

design in the City's latest 2013 CSO Plan Amendment (CH2MHill, 2014a) were different from the 2005 Plan (City, 2005b). The revised design did not account for runoff from snowmelt, which is a significant factor in Spokane, and relied on simulated or modeled storm data instead of actual observed rainfall data (CH2MHill, 2014a). The 2013 CSO Plan Amendment also does not account for the likelihood that larger storms will likely recur more frequently in the future due to climate change (CH2MHill, 2014a). These less conservative design assumptions significantly underestimate the volume of runoff generated by storms over the last 20 years in several CSO basins and the plan relies on future implementation of GI and adaptive management approaches to adapt to these future anticipated increases in stormwater runoff.

> "*Uncertainty around climate change is not currently addressed in CSO facility sizing…Each basin will have an adaptive management strategy of additional storage. For basins where GSI [Green Stormwater Infrastructure] is feasible, implementation of GSI retrofits will also be considered for adaptive management.*" (CH2MHill, 2014a, p.18)

These changes in assumptions reduced the total storage volume of the planned CSO tanks from 58 million gallons to 15 million gallons (MG) (CH2MHill, 2014a). The impact of these changed assumptions is particularly apparent in the reduction of design storage volume for CSO 26. Using the simulated model in the 2013 CSO Amendment Plan, the City estimated that CSO 26 would require a 2 MG storage tank to comply with its NPDES permit discharge requirements, approximately 80% smaller than the 2005 Plan design volume of 7.1 MG (Exhibit 4-2).

However, the runoff generated from the simulated rainfall model in the 2013 CSO Amendment does not reflect the actual historical CSO record, particularly for CSO basins which experience a high frequency of CSO discharge, such as CSO 26. Using the City's observed CSO discharge data between 2001 and 2012 (from the City's monthly CSO reports), a 2013 evaluation by CH2MHill showed that a larger 3.65 MG tank would be required at CSO 26 to comply with NPDES permit requirements, approximately 80% larger than the design volume in the 2013 CSO Amendment Plan (CH2MHill, 2014a). When more recent observed discharge data from 2000-2018 is included in the analysis, the projected volume to achieve the stated design target for CSO-26 of 0.5 overflows per year, the required volume increases to 5.39 MG, more than twice the volume of the CSO 26 storage tank presented in the 2013 CSO Plan Amendment (Exhibit 4-2).

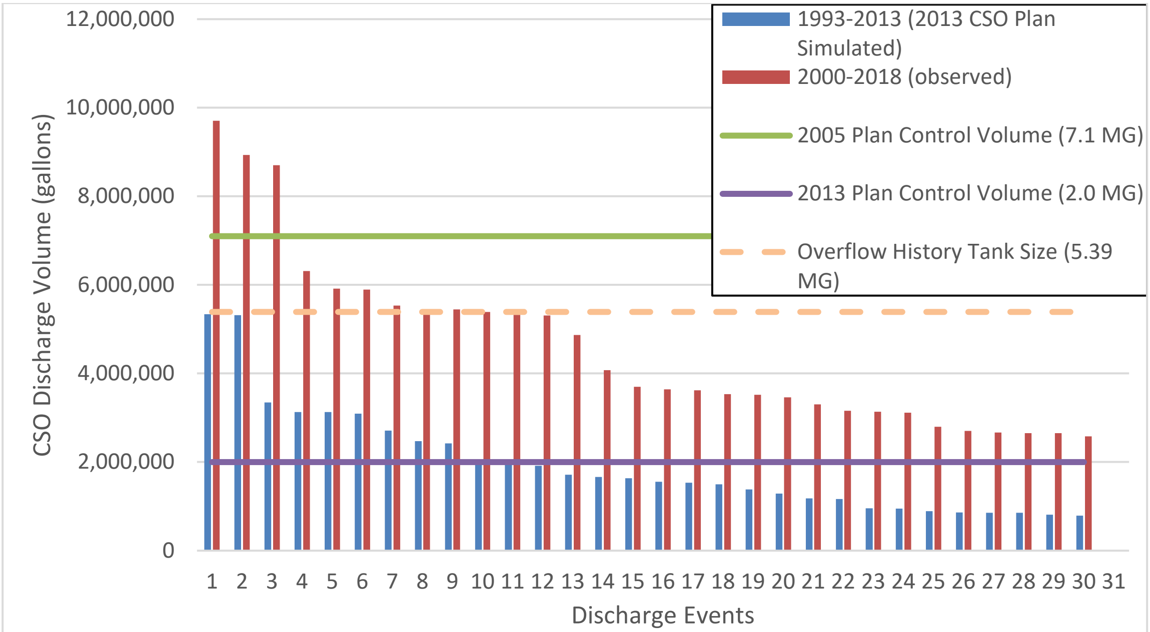

Exhibit 4-2. Summary of CSO Volume and CSO Tank Size Estimation 2000-2018
Source: CH2MHill, 2014a, City, 2001; 2002; 2003;2004;2005a; 2006;2007;2008;2009a; 2010;2011;2013b;2014b;2015f;2016c;2017a;2018d;2019b)

Ultimately the City chose to combine CSO 25 and 26 in one outfall and the tank was designed to contain 2.2 MG of overflow (City, 2017a). Over the last 20 years, there have been 39 CSO events in excess of 2.2 MG/year in CSO 26 alone, which would result in an expected overflow frequency of nearly 2 events per year. This is twice the NPDES permitted discharge frequency limit and 4 times the City's design assumption of 0.5 events per year for this basin.

The 2013 CSO Plan Amendment elected to manage uncertainty in the previously modeled CSO volumes through planned future adaptation using GSI in CSO watersheds.

> "*Uncertainty from a variety of sources described earlier influenced the City's decision on risk tolerance in individual CSO basins and incomplete separation areas. The City's decision was based on this uncertainty, and on the presence or absence of a 'safety out,' or a backup plan, should a built facility not be large enough to meet the performance standard of one overflow per year per outfall over a 20-year moving averaging period. The target overflow frequency for low risk basins is 18 overflow events over 20 years, 15 overflow events over 20 years for medium risk basins, and 10 overflow events in 20 years for high risk basins.*" (CH2MHill, 2014a, p. 19).

> "*If the projects shown in Table 10 are built and fail to meet the performance standard of one overflow per year per outfall based on a 20-year moving*

> *averaging period, the City will take steps to address this by implementing a 'safety out.' In the development of the projects for each basin, a 'safety out' was developed for each basin. For most basins the safety out consists of constructing GSI to reduce the amount of runoff entering the combined sewer system, or to construct additional storage.*" (CH2MHill, 2014a, p. 25).

The downsizing of this and other CSO storage tanks was intentionally done with the expectation that GI controls would reduce stormwater flows and reduce the size of the tanks required. As described by Mayor Condon:

> "*We built in mitigation for climate change and for <u>downsizing some infrastructure</u> by committing <u>to remove stormwater when we rebuilt streets</u>… In the end, we cut about $150 million of cost out of our Clean Water plans through this effort.*" (Condon, 2019, p.3, emphasis added)

As an example, the City has claimed that over $2.5 million in costs along High Drive are attributable to PCBs, however the City's project description suggests that the GI projects along High Drive are intended to reduce CSO discharges from outfall 24. The City's project description states that:

> "*This project will design and construct replacement of an undersized sewer pipeline, increasing capacity for combined sewer flows to the treatment plant. Stormwater will also be captured, treated and infiltrated in bioretention facilities along High Drive from CSO Basin 24 instead of being conveyed to the combined sewer. This project will reduce combined sewer overflows to Hangman Creek in the City of Spokane*." (Ecology, 2017b, p. 1).

It is clear, based on the City's own analysis and statements that the planned CSO controls are known to be undersized to meet the design goal of one overflow, per outfall, per year. In order to save over $150 million upfront in capital costs, the City has planned to integrate GI into CSO basins to mitigate the risks associated with these undersized facilities.

5. OPINION 4: THE CITY CONCEDES THAT ALL ASPECTS OF THE DESIGN, CONSTRUCTION, AND OPERATION OF THE PLANNED OR IMPLEMENTED UPGRADES TO THE STORM WATER AND WASTEWATER SYSTEMS ARE REQUIRED INDEPENDENT OF THE PRESENCE OF PCBS.

The City admits that all aspects of the stormwater and wastewater system upgrades including MS4s, GI, CSO and NLT design construction and operation are related to the City's regulatory obligations under City's NPDES permit coverage for the stormwater system, CSS and the RPWRF and are needed independent of PCBs (City 30(b)(6), Davis, 2019a, 74; City 30(b)(6)[17], Hendron: 2019, 214-215).[18]

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[17] My question was are there any design elements of any of these MS4 systems that are designed uniquely, "uniquely," you understand what that word means, uniquely to address PCBs?
MR. LAND: Objection. Asked and answered. And misleading.
(Pause in proceedings.)
THE WITNESS: Can I take a break?
Q. No. There's a pending question.
MR. LAND: You can answer the question, and then you can take a break.
(Pause in proceedings.)
THE WITNESS: Okay.
(Pause in proceedings.)
THE WITNESS: No.

[18] Q: Let me ask you this more globally: Can you cite, with respect to the CSO reduction plan, could you cite to me any engineering element that was made necessary because of PCBs, but would have been dispensed with had PCBs never been invented?
A: I do not think so.
Q: And the same question with the NLT construction and design.
A: I would say yes.
Q: The same answer?
A: Yes.
Q: So there's no element – Design element that was made necessary specifically to address PCBs that could have been dispensed with had PCBs never been invented.
A: Not that I'm aware of.
Q. The same thing with the MS-4 projects that we see throughout the city and have been implemented, is there any design aspect of any of those that were made necessary by PCBs and that could have been dispensed with had PCBs never been invented?
A. In terms of design, I would say, no.

5.1 CSO Management Measures

The City has admitted that its CSO control measures are necessary to maintain compliance with its NPDES requirement to reduce the number of CSO occurrences to one discharge, per outfall, per year. The control measures implemented in its CSO basins would be no different, had PCBs never been invented (City 30(b)(6), Hendron, 2019 228:6-17[19]). The City has admitted that CSO infrastructure including tanks had been conceptualized and designed for control of CSO discharge volume well before PCBs were detected in the City's wastewater conveyance system (City 30(b)(6), Hendron, 2019, 132: 9-24).[20]

5.2 RPWRF NLT Upgrades

At no point in the history of the RPWRF has treatment of PCBs been a requirement under the City's NPDES permit obligations as admitted by the City (City 30(b)(6), Hendron, 2019, 194).[21] The City has also admitted that the no element of the NLT upgrades at the RPWRF are designed specifically for the removal of PCBs and that the upgrades are primarily intended to decrease discharge of phosphorus to levels stipulated in the NPDES permit for the RPWRF to meet DO TMDL requirements (City (30(b)(6), Coster, 2019,

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[19] Q: Sir, with respect to the – all of these storage tanks that had been built or in the process of being built, they were – I think we have established that they were being built because of requirements of – legal requirements of the permits, correct?
A: The permit required, yes.
Q: Am I correct that all of that construction would have been necessary to comply with those permits, even if PCBs had never been invented?
A: I believe so, yes.

[20] Q: And those were the storage tanks that were – I saw first mentioned in a 1972 city document, right?
A: Yes.
Q: So, this is further development of that theme, right?
A: It appears to be, yes.
Q: And the idea is that you can park excess water in these storage tanks until capacity is sufficient to handle it at the treatment plant?
A: Correct.
Q: And again, in 1977, this is before PCBs were ever detected in the water system, correct?
A: Yes.

[21] Q: And I think you have agreed that there's never been a quantitative limit on PCB discharge from your plant, correct?
A: In no prior permits, correct.

27[22]; City 30(b)(6), Hendron, 2019, 265[23]). The City has further admitted that there is no element of NLT construction or design that was made necessary by PCBs or that could have been disposed of had PCBs never existed (City 30(b)(6), Hendron, 2019, 214[24]).

The City's Integrated Clean Water Plan also proposes actions to address the discharge of various constituents to the Spokane River from the City's wastewater conveyance and treatment system as part of an effort focused on achieving a "Cleaner River Faster". These project actions are required for control of conventional wastewater constituents, primarily phosphorus, to meet the DO TMDL requirements pursuant to the City's NPDES obligations, and these actions are not increased in cost or scope due to the presence of product PCBs. Among those actions is the continued operation of the RPWRF NLT system through the non-critical season (November through February), in addition to the critical season (March through October) operation which is required by the facility's NPDES permit, as discussed below.

Pursuant to its current NPDES permit, the City was required to implement an additional phosphorus removal process at the RPWRF by March 2018 (Ecology, 2011a) to meet compliance goals for DO based TMDLs. This requirement is irrespective of the presence of other constituents. The current 2011 NPDES permit states "*Beginning March 1, 2018, the Permittee must have installed the full phosphorus removal process train including*

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[22] Q: Okay, you would agree, Mr. Coster, that the NLT system was not designed to remove PCBs; correct?
A: Yes.

[23] Q: It says: There are no PCB design loadings associated with the NLT treatment system design. NLT was constructed solely for phosphorous removal and compliance with the DO TMDL requirements. While additional PCB removal may be achieved through this system, it is not verified that PCB removal was not a design consideration. Is that what the city said?
A: Yes.

[24] Q: Let me ask you this more globally: Can you cite, with respect to the CSO reduction plan, could you cite to me any engineering element that was made necessary because of PCBs, but would have been dispensed with had PCBs never been invented?
A: I do not think so.
Q: And the same question with the NLT construction and design.
A: I would say yes.
Q: The same answer?
A: Yes.
Q: So there's no element – Design element that was made necessary specifically to address PCBs that could have been dispensed with had PCBs never been invented.
A: Not that I'm aware of.

chemical addition and have operational the technology needed to comply with the following effluent limitations during the season March 1 to October 31" (Ecology, 2011a, p. 8).

Planning to meet NLT requirements for phosphorus removal began with preliminary pilot studies in 2005, followed by a 2-year pilot study from 2007-2009 (the P-Pilot) which evaluated various treatment options including conventional filtration and microfiltration (Esvelt, 2014). The main objective behind the pilot test was the collaborative development of a “Managed Implementation Plan (MIP)” to achieve the objectives of the TMDL over a 20-year time frame. The MIP called for pilot treatment studies to develop the most likely BAT treatment process to achieve the objective of phosphorus removal. During the pilot test, limited sampling was conducted for an expanded list of analytes including PCBs, BOD, metals, PBDEs, pharmaceuticals, personal care products, endocrine disrupting compounds and TSS which were not part of the functional pilot design objective of increased phosphorus removal. The results were inconclusive regarding removal of PCBs. In conclusion, the P-Pilot led to the selection of micro filtration as the treatment alternative, a technology selection unrelated to the presence of PCBs. The City has admitted that sufficient testing to evaluate PCB removal by the NLT was not conducted by the City to draw any scientifically reliable conclusions regarding PCB removal efficiencies (City 30(b)(6) Coster, 2019, 30- 31)[25]

This was later underscored by the City’s comments on the draft 2016 NPDES permit to Ecology:

> *“There is currently only limited data on the additional benefit of year-round NLT for PCB removal…While the City is hopeful that NLT will provide cost-effective PCB removal at RPWRF, there is not enough data yet to conclude it should be operated year round to control PCBs”.*
>
> *“Piloting and design are specifically geared for nutrient removal and NLT must be optimized commensurately to achieve the intended Net Environmental Benefit. Although NLT appears capable of further reducing PCBs, the minimal data collected during piloting may not represent the Non-Critical season and, in any case, is too limited to provide statistical significance.”* (City, 2016b, p. 1 and p. 5)

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[25] Q: And so the City is writing here that the City didn’t test for PCB removal by NLT sufficiently to draw any scientifically reliable conclusions on PCB captured by the NLT system; correct?
A: Correct.

Further pilot testing occurred in 2014 and 2015 (the side-by-side pilot) which led to the selection of the Pall Membrane Filtration system (Esvelt, CH2MHill and City of Spokane, 2016). Once again, the objective of this pilot test was to evaluate phosphorus removal and parameters relevant to operation and maintenance of the membrane microfiltration system. Design and implementation began two years later, in 2016. In June 2017, Ecology determined that the City would fail to meet its December 31, 2017 control requirement for both phosphorus removal and control of its CSOs as specified in Section 13.G.2 of the NPDES permit. As a result, Ecology issued Administrative Order 14235 which established corrective actions, stating that "*On or before November 1, 2020, the City of Spokane must: Send Ecology a notice of the substantial completion of the Next Level of Treatment facility*" (Ecology, 2017a, p. 2).

Because operation of NLT during the non-critical season was selected to reduce overall mass discharge of a wide range of constituents (phosphorus, TSS, fecal coliform, zinc, and PCBs), costs to operate the NLT would be incurred by the City regardless of the presence of PCBs. Non-critical season filtration would extend the operation of the NLT system through the remainder of the year to provided additional constituent treatment year-round. In addition, the P-Pilot states that trace levels of PCBs present in the secondary effluent from the RPWRF had no effect on the selection of the NLT treatment alternative (Esvelt, 2014). Therefore, there will be no effect on operations costs, materials handling, or disposal costs, all of which are the result of need for phosphorus, metals and TSS removal requirements pursuant to the City's NPDES permit requirements, not PCBs.

Non-critical season operation of the NLT filtration system was evaluated within the Integrated Plan against other stormwater and CSO control measures to determine which alternative provided the most economical reduction of loading of various classes of constituents to the Spokane River. This analysis estimated that non-critical season treatment will remove an annual mass of roughly 85,000 pounds of phosphorus, 330,000 pounds of suspended solids, 425 pounds of zinc, 0.015 pounds of PCBs, and would also reduce fecal coliform loading to the Spokane River (CH2MHill, 2014b; Appendix E). Non-critical season filtration was selected through the Integrated plan because it was the most cost-effective way to reduce the overall mass discharge of a wide range of constituents, as compared with other available treatment alternatives.

Furthermore, it is not recommended to shut-down membrane filter system operations of this type for extended periods of time. The City has admitted that Pall Corporation formally recommends avoiding membrane system shutdowns in its Operations and

Maintenance (O&M) Manual (City 30(b)(6), Coster, 2019 43:4-13)[26]. The City has also admitted that Pall warns against long-term shutdowns of greater than 72-hours in its O&M manual (Pall Corporation, 2017) due to the potential for biological growth on the filters and piping that can subsequently affect system performance[27].

In addition, the City claims future costs for increased membrane replacement frequency arising from the need to operate the membrane during the non-critical season. However, the City's Request for Proposal (RFP) during the membrane supplier procurement process specifies a 10-year warranty period and does not differentiate between operating seasons (MWH and Slayden, 2016a). Pall's executed Purchase Agreement with the City includes provisions for a 11-year (132-month warranty) on the membrane modules (MWH and Slayden, 2016b). The design basis used in developing Pall's executed Purchase Agreement assumes year-round operation, as reflected in the City's RFP. Because Pall's 11-year warranty covers year-round operation of the membrane modules and is not specific to the critical season, operation of the membrane during the non-critical season does not affect the warranty terms. Therefore, the City will not incur any additional membrane replacement costs from operating the membrane during the non-critical season.

There is no current numerical limit for PCB discharges from the RPWRF. In the City's comment letter on the draft RPWRF NPDES discharge permit (City, 2016b) the City points out that the current PCB concentration in the Spokane River meets the Washington State standard, and the NLT was not designed to mitigate PCBs, stating:

> *"the reasonable potential analysis (RPA) discussed on page 37 of the Fact Sheet (and calculated on page 83), indicates that RPWRF does not have the reasonable potential to cause an exceedance of the water quality standard for PCBs…The City would point out that based on PCB monitoring conducted by SRRTTF in 2014-2016, the Spokane River appears to be actually below the water quality criteria of 170 pg/L on an annual average basis"* (City, 2016b, p. 3).

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[26] Q: And you would agree that Pall Corporation is here formally recommending in writing that the City of Spokane avoid system shutdowns, if possible; correct?
A: That's what the assertion is by the manufacturer.

[27] Q: Okay. And so there is concern here that Pall Corporation is expressing to the City, the purchaser and owner of this NLT membrane system, that for shutdown greater than 72 hours, there's concern for biological growth on the filters or piping; correct?
A: It appears to say that.

> *"There are no PCB design loadings associated with the NLT treatment system design. NLT was constructed solely for phosphorus removal and compliance with the DO TMDL requirements. While additional PCB removal may be achieved through this system, it is not verified and PCB removal was not a design criteria"*(City, 2016b, p. 4).

5.3 Stormwater Infrastructure Improvements

All of the City's claimed past and future stormwater infrastructure upgrade costs are related to implementation of stormwater BMPs that are not targeted at any specific constituent and only reduce PCBs to the extent that they reduce suspended sediment loads, which is the most basic function of stormwater management measures. The stormwater control measures described by the City are common BMPs for basic stormwater constituents such as suspended sediments, nutrients, oils, and pesticides. Each of these measures are needed to meet the basic permit requirement of installation of stormwater controls to the maximum extent practicable and are not increased in scope or cost due to the presence of PCBs. The City has admitted that there are no aspects of their claimed stormwater management systems which are uniquely designed to address PCBs (City 30(b)(6), Davis, 2019a, 74; City 30(b)(6), Davis, 2019a, 101:18 – 102:6[28]; City 30(b)(6), Hendron, 2019, 214-215).

Stormwater related actions identified by the Integrated Plan can be placed into three general categories of mitigation measures: standard stormwater BMPs, general infrastructure maintenance and improvements, and programs focused on management of non-Monsanto related by-product PCBs which continue to be produced legally as part of many manufacturing processes. The City's stormwater discharges are regulated under the Eastern Washington Phase II Municipal Stormwater NPDES permit, which incorporates standard stormwater management requirements for all small municipalities in Eastern Washington, in addition to site-specific limitations on discharges associated with Spokane River TMDLs for certain metals, phosphorus and dissolved oxygen (Ecology, 1999; 2010b; 2014). The Phase II Municipal Stormwater NPDES permit requires that the City must reduce the discharge of constituents to the maximum extent practicable and use

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[28] Q: Fair enough. So just to summarize before we go to the next subject, would it be fair to say, based upon the documents that we've reviewed just now, that the kinds of methods, the best management practices that are incorporated in the MS4 projects that comprise the claim in this case, had been recognized over the years and evaluated for their effectiveness in the removal of all kinds of constituents?

A: Yes.

Q: And none of them, by design, are uniquely devoted to removing PCBs, as opposed to this long list of other constituents.

A: Yes.

All Known, Available, and Reasonable methods of prevention, control and Treatment (AKART) to prevent and control pollution of waters of the State of Washington. In addition, several of the claimed stormwater control costs are part of the City's design to reduce stormwater flow volume to the City's CSO basins as a step toward meeting the City's permit requirements under the CWA for control of the frequency of CSO discharges.

Infrastructure maintenance and improvements identified in the Integrated Plan are intended to reduce the volume of stormwater discharged to the combined sewer system and to provide the ancillary benefit of reducing the load of non-stormwater constituents in stormwater discharges. The City has planned to integrate GI components such as bioswales, permeable pavement, and infiltration ponds/rain gardens into general infrastructure improvements to further reduce stormwater volume (CH2MHill, 2014b). The Integrated Plan states:

> *"During the alternative evaluation phase, it was determined that implementing GI solely for the purpose of CSO reduction is not cost-effective when compared with storage and conveyance facilities. However, if GI can be implemented jointly with other infrastructure improvements, such as road repaving, water main replacements, and other improvements in the right-of-way, the marginal cost of implementing GI can be reduced"* (CH2MHill, 2014b, p. 4-17).

These projects include city infrastructure improvements such as water main replacement, sidewalk improvements, and pavement repair. In many instances, the City has claimed costs for decorative features, amenities, signage, and city infrastructure which have no relation to stormwater management. Moreover, these stormwater management actions are not targeted at any specific stormwater constituent, but they are implemented as a BMP for general stormwater control on new infrastructure projects in the City. Mayor Condon presented in his testimony to congress that these actions are voluntary and aimed at general diversion of stormwater:

> *"We are voluntarily removing stormwater flows from our systems as we rebuild roads and complete other infrastructure projects to reduce the amount reach [sic] our river."* (Condon, 2019, p.2).

The City has claimed costs related to the following general infrastructure projects that allegedly are attributed to the need to reduce PCB discharges to the Spokane River (City, 2019a) but in fact, are required to meet stormwater permit requirements, regardless of the presence of PCBs in the Spokane River.

5.3.1 Broadway SURGE

Broadway Avenue was the first project chosen for the Spokane Urban Runoff Greenways Experiment (SURGE). The City has admitted that this project has nothing to do with management of PCBs (City 30(b)(6) Davis, 2019b, 251 – 260)[29].

SURGE is a program based on a "Green Streets" program in Portland, OR and was developed to demonstrate and determine criteria for retrofitting existing curb and gutter systems with plant based low impact development (LID) stormwater treatment systems in Spokane's urban environment. The Broadway SURGE goal was to separate stormwater from the combined sewer system, treat runoff by bioretention in a series of "storm gardens" (Exhibit 5-1), and infiltrate treated water to reduce stormwater to CSO 23 and overall improve the water quality of the Spokane River and meet requirements of the NPDES Phase II Eastern Washington Stormwater permit (Davis and Papich, 2017; City, 2009b). The project also included the first installation of permeable concrete sidewalk by the city and its results were intended to be used as future design criteria for future LID design retrofits.

Broadway SURGE was first introduced to the neighborhood in March 2008 and construction was planned to begin in 2009 but was delayed and completed in November 2010. The City received a 2009 American Recovery Reinvestment Act (ARRA) loan for $599,000 with 50% principal forgiveness[30] to fund Broadway SURGE.

A 2010 Construction Inspection Checklist completed by Ecology describes the project as follows:

> "*Construction of a series of stormwater treatment areas (37 planters) between the curb and sidewalk to intercept stormwater runoff on both sides of Broadway street. Runoff will be filtered through mulch, top soil, and gravel enhanced base before infiltration. Stormwater system will include curb and gutter, inlets into each planter, infiltration planters, and pervious sidewalk. Project will benefit water quality by capturing stormwater and filtering runoff before infiltration into*

[29] Q. So my question was this projection was not undertaken because of PCBs, was it?
A. I don't remember from this time, of PCBs being the concern for us doing this project. It was generally getting stormwater out of the river.

[30] https://www.epa.gov/sites/production/files/2015-04/documents/innovative_stormwater_management-washington.pdf

the area's aquifer. Project will reduce nitrogen and phosphorus loading directly to the Spokane River." (Ecology, 2010c, p. 1)

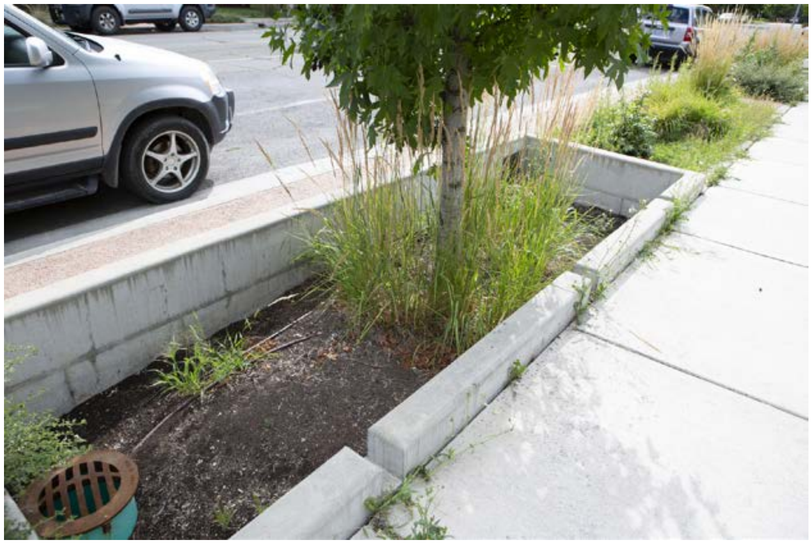

Exhibit 5-1: Example of Broadway SURGE storm water treatment area

Because of improper installation, the permeable concrete sealed and did not provide effective infiltration of stormwater. A miscommunication between City departments led to the plantings in the vegetated swales to not be watered for two years (Davis and Papich, 2017). This project is part of the necessary stormwater flow reduction needed to control CSO 23. The design and implementation costs of this infrastructure upgrade are unaffected by the presence of PCBs.

5.3.2 Pacific and Perry

This project expands and improves an existing infiltration facility (Exhibit 5-2) to accommodate additional input to divert stormwater from areas of 2nd and 3rd avenue, which previously drained to a combined sewer system (City, 2015h). The planned infiltration area is designed to manage more than double the calculated volume required for the 2nd and 3rd avenue drainage area alone and will be able to accommodate future projects, such as the WS-DOT I-90 project. The City admits that this infiltration facility is designed to mitigate combined sewer overflow events (City, 2015h):

"*This project proposes to expand and improve an existing undeveloped infiltration area to include other substantial portions of City street runoff that currently drain to a combined sewer system.*" (City, 2015h, p. 1)

Therefore, this project was also not installed for the purpose of mitigating PCBs. The water quality benefits of the Pacific and Perry facility were detailed in the project's preliminary design report:

1. *"Reduce and/or eliminate combined sewer overflows to the Spokane River*

   Combined sewer overflow events are predominately caused by wet weather flows into the system. By separating stormwater out of the system, the potential for these overflows is greatly reduced and/or eliminated.

2. *Infiltrate stormwater runoff at the source*

   Treating and infiltrating stormwater runoff near its source better mimics natural conditions.

3. *Increased capacity in the associated sewer system*

   Removing stormwater from the combined sewer system increases capacity for actual sanitary sewage and reduces storage and treatment costs." (City, 2015h, p. 3)

Exhibit 5-2: Pacific and Perry at 2nd Avenue

There is no mention of PCBs within the preliminary design report (City, 2015h). Furthermore, the City received a grant of $1,037,362 from Ecology for implementation

of the Pacific and Perry Infiltration Facility (City, 2019a). The City admitted that the claimed damages do not account for the grant received from Ecology (City 30(b)(6), Davis, 2019b, 320)[31]. Several claimed costs are completely unrelated to stormwater, such as vehicle gate assemblies (Exhibit 5-3; PCB-SPOKANE-08116410).

Exhibit 5-3: Vehicle gate at Pacific and Perry 2nd Avenue

5.3.3 WS-DOT I-90

The City has also claimed costs associated with diversion of stormwater from a section of I-90 that currently drains to the City's combined sewer system, that may be routed to

[31] Q. And move on to another project. Is the Pacific and Perry Project claimed by the City as damages, Pacific and Perry stormwater facility?
A. Yes.
Q. And what's the claimed damages for that project, please?
A. $1,401,539.37.
Q. Is there -- did the City obtain a grant or a loan for that project?
A. I believe we received a grant. Yes, we have a grant in the amount of $1,037,362.00.
Q. And did the City reduce its claimed damages in this case by that grant received from --
A. No.
Q. -- ecology.

the Pacific and Perry infiltration system as part of the North-South Corridor Project (City, 2015h). These efforts are directly associated with the Pacific and Perry Facility.

5.3.4 High Drive

Like Broadway SURGE and Pacific and Perry, the Project Charter for the High Drive Project (29^{th} – 21^{st}) lists four objectives:

1. Increase capacity of the combined sewer main
2. Abandon existing CSO 20 regulator and outfall to Latah Creek
3. Separate stormwater from the combined sewer main
4. Reconfigure the roadway to more closely tie in with recent High Drive improvements and provide pedestrian amenities. (City, 2017d)

This project is related to separation of stormwater from a CSO basin, and part of the City's required actions to meet its CSO reduction targets under the City's current NPDES permit. No samples have been collected to date to even determine if PCBs are present in the residential drainage area of the project. Exhibit 5-4 shows an example of an infiltration facility near High Drive.

The City's presentation of the measure and method for determining the water quality benefit and overall success of this project focuses on separating stormwater from the CSO and eliminating CSO overflow events, not on PCB removal:

> *"Two measures will determine the success of this project. The first is no overflows to Hangman Creek. The overflow regulator will be removed and there will be no connections to the creek. However, true success will be measure by no basement backups or street flooding caused by the removal of the outfall.*
>
> *The second measure will be the removal of stormwater from the CSO Basin 24 system. The City of Spokane began monitoring and reporting combined sewer overflows to the Spokane River in 2000. Monitoring equipment will be installed with the improvements of CSO Basin 24. The monitors will be installed to record flow both into the treatment plant and overflow to the river. Data collected from monitoring will be reported monthly and combined into an annual summary. This monitoring will be used to determine if enough stormwater has been removed from the combined sewer system to limit the overflow in CSO Basin 24 to one or less overflows per year.* (Ecology, 2017b; City, 2017b; PCB-SPOKANE-02019523).

Exhibit 5-4: Example of an infiltration facility along High Drive

The project description states that bioretention areas will be visually inspected to check for flooding and flow bypassing. No part of this work is attributable to PCBs.

5.3.5 East Central Stormwater Improvements

The East Central Stormwater Improvements Projects are a series of small projects that are orphan portions of several CSO mitigation projects, lumped together into a single project for bidding purposes (Studer, Personal Communication, 16 August 2017).

1. 2nd Ave Stormwater: Reconstruct piping to connect to Pacific/Perry Stormwater facility (CSO)
2. Riverside Avenue Stormwater: Separate Stormwater from CSO along Riverside Avenue
3. Liberty Park Stormwater: Separate stormwater from the CSO at 4 locations
4. 4th Avenue Tree Planting: Plant trees as part of CSO 33-1 mitigation
5. Trent and Waterworks: The Trent Avenue Stormwater Improvement design report states that all described areas within the project route stormwater to the City's

combined sewer system, separating stormwater from the CSO is assumed to have general water quality benefits (Exhibit 5-5) (City, 2014c).

Exhibit 5-5: Stormwater facilities at Trent Avenue and Waterworks Street

Like the other stormwater separation projects in CSO basins, these projects are designed to help meet NPDES permit conditions, while reducing the size of required CSO basins, and reducing the overall cost of CSO controls to the City (City, 2017e). The City admitted that the claimed damages do not account for the grant received from Ecology (City 30(b)(6), Davis, 2019b, 309-310).

5.3.6 Peaceful Valley/South Gorge Trail Project

The 2019-2024 Citywide Capital Improvement Program states that this project was designed to separate stormwater from CSO Basin 22b to limit overflows (City, 2018b). The plans to construct the South Gorge trail have been discussed for decades and there is no connection between this project and mitigation of PCB discharges.

> "*The city has talked about a trail on the south bank for at least 30 years. Grand plans for the gorge stretch back even further. A Spokane park plan drafted in 1908 called for the Great Gorge Park.*"[32]

The grant agreement for the Peaceful Valley Project states:

> "*This project will provide treatment for total suspended solids (TSS), oil (total petroleum hydrocarbons), and dissolved copper and zinc, and will reduce the volume of stormwater that reaches the Spokane River by increasing stormwater infiltration*". (Ecology, 2019, p.1)

The City admitted that the claimed damages do not account for the grant received from Ecology (City 30(b)(6), Davis, 2019b, 335-336)[33]. The City's contention that this project is designed solely for mitigation of PCBs is not supported by the City's own documents. Kiosks interpretive signs, and pet waste stations at Peaceful Valley/South Gorge were included in project costs and have no relevance to mitigation of PCBs. (City, 2019a; SPOKANE-PRR-2616830; SPOKANE-PRR-2616701; Exhibit 5-6; Exhibit 5-7)

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[32] http://www.spokesman.com/stories/2018/jun/21/south-gorge-trail-project-set-to-break-ground-in-2/

[33] Q. Okay. So what's the claim cost for the Peaceful Valley stormwater Separation Project?
A. The costs – the claim costs are $2,417.74 – or 73 cents.
Q. And, then, the future costs are how much?
A. 1.9 -- $1,920,000.00.
Q. And has the City reduced its either past or future claim damages based upon receipt of the grant that's documented in Exhibit 63?
A. No.

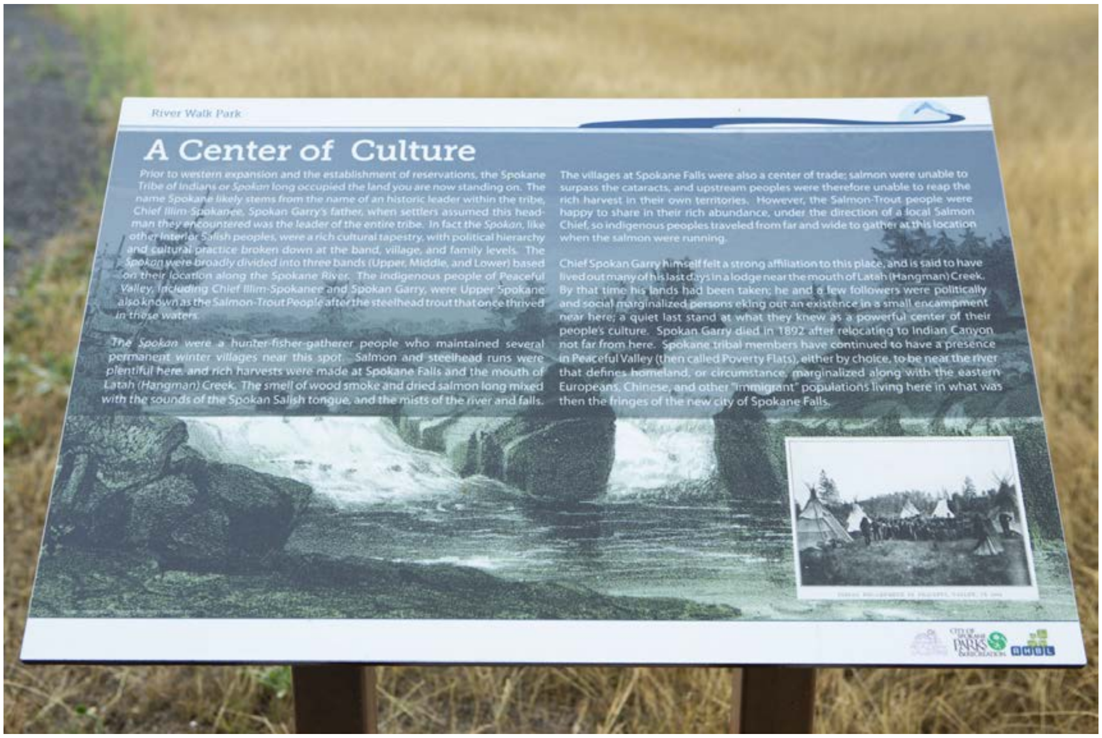

Exhibit 5-6: A Peaceful Valley/South Gorge interpretive sign.

Exhibit 5-7: Pet waste station at Peaceful Valley.

While pet waste stations improve stormwater quality by removing pet waste from stormwater runoff, they are unrelated to the presence of PCBs.

5.3.7 Spokane Falls

Spokane Falls Boulevard, Post to Division Street is a street improvement project that integrates stormwater improvements. The 2019 Citywide Improvement Plan states that street construction includes a full depth roadway, repair sidewalk, lighting, communication conduit and cable, signal and utility upgrades. The project will provide stormwater treatment and separation along Spokane Falls Blvd (City, 2018b). Currently, the runoff drains to the CSS. The plan also states that:

> "*downtown area has a history of rain related backups and surcharging. This project will provide additional capacity for the rain related issues.*" (City, 2018b, p. 926)

Other projects that are involved with road construction include sewer replacement and water main replacement. The water main in this section of Spokane Falls Boulevard was installed in 1891 and will be replaced. Separating stormwater from the combined sewer and retrofitting the outdated watermain are the overall goal for the project. PCBs are not a part of this goal nor are any aspects designed specifically to address PCBs.

5.3.8 Cochran Basin Stormwater Separation

The Cochran Basin is located north of the Spokane River (Exhibit 3-5). It covers 5,328 acres and it is the largest of Spokane's separated stormwater systems. It has an average annual runoff volume of 296 million gallons per year (MG/year) (CH2MHill, 2014c). This stormwater basin is a priority for the City because it contributes the largest volume of stormwater to the Spokane River.

In 2012, CH2MHill prepared an assessment of potential pollutant removal in the Cochran Stormwater basin on behalf of the City, contributing to the City's Integrated Planning Process. The purpose of the assessment was to:

> *"compare the pollutant removal potential between combined sewer overflow (CSO) project discharging into the Spokane River and stormwater projects in the Cochran Basin…The pollutants selected for analysis were: total suspended solids (TSS), zinc, lead, total phosphorus, and fecal coliform. These pollutants are all listed as pollutants of concern on the Spokane River's 303d listing, and were selected to give a range of pollutant types"* (CH2MHill, 2012, p. 1).

In 2018, Ecology described the stormwater management goal for the Cochran Basin infiltration project (Exhibit 5-8) as part of the City's management strategy to address the phosphorus, ammonia, and CBOD load under the City's existing DO stormwater TMDL requirements:

> *"The City of Spokane completed an Integrated Clean Water Plan, which includes preliminary phosphorus, ammonia, and CBOD monitoring data in stormwater. The Plan proposes major stormwater management facilities for the Cochran Basin, which encompasses about half of the City's stormwater system."* (Ecology, 2018b, p. 30)

Exhibit 5-8: An example of a Cochran Basin infiltration facility at TJ Meenach Blvd and Pettet Drive

The TMDL limit for discharges of phosphorus to the Spokane River is 6.1 pounds per day (lbs/day) for all Washington state stormwater sources combined (CH2MHill, 2014b). Based on the updated Spokane River TMDL Implementation Report (Ecology, 2018b), the average concentration of phosphorus in Cochran Basin stormwater from 2012-2016 was 0.85 mg/l. Using the estimate of 296.5 MG/year discharged from the Cochran Basin (CH2MHill, 2014b), it can be calculated that on average Cochran Basin contributes 5.75 lbs of phosphorous to the Spokane River each day or 94% of the total permitted

phosphorus load for all Washington stormwater runoff. For this reason alone, the control and infiltration of Cochran Basin stormwater is a priority for Spokane to meet its TMDL stormwater compliance requirements.

Although the project will result in some incidental reduction in total PCB load, there is no impact to either the project scope or cost due to the presence of trace PCBs in the stormwater. Of the $25,630,000 cost claimed by the City, the City has already been awarded $18,852,115 in Ecology grants (City, 2019a; Appendix B).

5.3.9 River Runoff Reduction

The River Runoff Reduction project installed drywells on residential streets to reduce the amount of untreated stormwater being conveyed to the Spokane River through MS4s. The project was divided into two phases and was construction in conjunction with City of Spokane 10-Year Street Bond projects. The goal of this project was to reduce stormwater discharges to the river. Drywells were thought to be a simple and low cost per impervious acre solution (Davis and Papich, 2017). The costs for these GI projects have been spread throughout the City and $397,693.95 of the City's claimed invoices are double counted, claimed both for the River Runoff Reduction project as well as the Finch LID and High Drive (Bernard – Grand Blvd) projects and also admitted by the City (Exhibit 5-9; City 30(b)(6), Davis, 2019a, 135 – 140).

Vendor	Date	City Invoice/Doc	Cost Claimed Under	Claimed Cost
HALME CONSTRUCTION INC	19-Oct-2015	RC5A0009043	River Runoff Reduction/ Finch LID	$ 160,245.18
HALME CONSTRUCTION INC	19-Oct-2015	RC5A0009044	River Runoff Reduction/ Finch LID	$ 19,014.01
MDM CONSTRUCTION INC	23-Oct-2015	RC5A0009004	River Runoff Reduction/ High Drive	$ 122,321.91
HALME CONSTRUCTION INC	18-Dec-2015	RC5A0009048	River Runoff Reduction/ Finch LID	$ 2,563.24
MDM CONSTRUCTION INC	13-Jan-2016	RC5A0009005	River Runoff Reduction/ High Drive	$ 93,549.61
			Total	**$ 397,693.95**

Exhibit 5-9: Costs double-claimed under multiple project headings
Source: City, 2019a

5.3.10 Sharp Avenue

The Sharp Avenue study was a demonstration project the City implemented in conjunction with Gonzaga University to evaluate permeable pavement as a LID technology. The project is designed and evaluated by engineering students and professors at Gonzaga University. The City has claimed $3,385,397.93 in costs related to this

project. However, the City received a $1,260,000 grant from Ecology for conducting the study (City, 2019a). The objective of the study was to determine the viability of permeable pavements in travel lanes, and will integrate a stormwater swale, tree planting, and standard paving (Exhibit 5-10).

Exhibit 5-10: Sharp Avenue Green Infrastructure

The 2014 Financial Assistance Package describes the objective of the Sharp Avenue Project as an evaluation project to determine where and how permeable pavements can be installed for general water quality improvement (City, 2014d). The document has no mention of PCBs.

The MS4 in the Sharp Avenue area does not drain directly to the Spokane River, but rather drains to Lake Arthur, a man-made water body adjacent to, and hydraulically connected to the Spokane River (City, 2014d). Lake Arthur has not been shown to be a source of PCBs to the Spokane River. The Ecology agreement summarizing the funding of the project states: "*This project will also provide treatment for Total Phosphorus, Nitrogen, Cadmium, Lead, Zinc, Total Suspended Solids, Petroleum Hydrocarbons, and PCBs and will also reduce flows to the Spokane River by increasing stormwater infiltration*" (Ecology, 2016a, p. 1).

The City has developed a monitoring plan to determine the treatment effectiveness of Sharp Avenue permeable asphalt for meeting Ecology's performance goals to qualify as a runoff treatment BMP. This study is limited to evaluation of pH, total suspended solids, total and dissolved metals, hardness, total petroleum hydrocarbons, and total phosphorus (City, 2018c). The project does not assess the reduction of PCBs and no aspect of this project is specifically designed to address PCBs and thus no costs associated with this upgrade can be attributed to the presence of PCBs.

5.3.11 Union Basin

The Union Basin contributes a much smaller volume of stormwater to the Spokane River than larger basins such as the Cochran Basin (CH2MHill, 2014b). However, due to the highly industrial zoning of the basin, the concentrations of many stormwater constituents are higher in the Union Basin than others. Industrial land use, a high percentage of impervious area and lack of sediment control in unpaved areas have enabled the spread of these constituents (Davis and Papich, 2017). The City cites the detection of elevated PCBs in the Union Basin as one of the reasons for implementation of this work. However, the City failed to analyze for any other stormwater constituent during collection of stormwater data in this basin. In the Integrated Plan, the City assumes the concentrations of other constituents are equivalent to the average concentration of the Cochran and Washington basins (CH2MHill, 2014b. p. D-6). For this reason, concentrations of many other stormwater constituents are also likely to be elevated relative to other basins.

The Union Basin includes approximately 29-impervious acres that discharges through an MS4. The stormwater is managed through three projects (Davis and Papich, 2017). The first project separated approximately 10 acres, using bioretention facilities and tree boxes at one intersection (Exhibit 5-11). The second project managed stormwater using bioretention facilities as part of the new Martin Luther King Jr. street project (Davis and Papich, 2017). The Union Basin Improvement Project Preliminary Design report indicates that approximately 21,535 square feet of the drainage area is diverted from the local CSO system but was additionally included in the Martin Luther King Jr. MS4 management project (City, 2015e). The remaining acreage of the basin will be treated in the Erie and Trent Stormwater facility. The City has claimed $1,142,285.12 in Union Basin stormwater improvements and has received a $1,000,000 stormwater grant from the Department of Ecology.

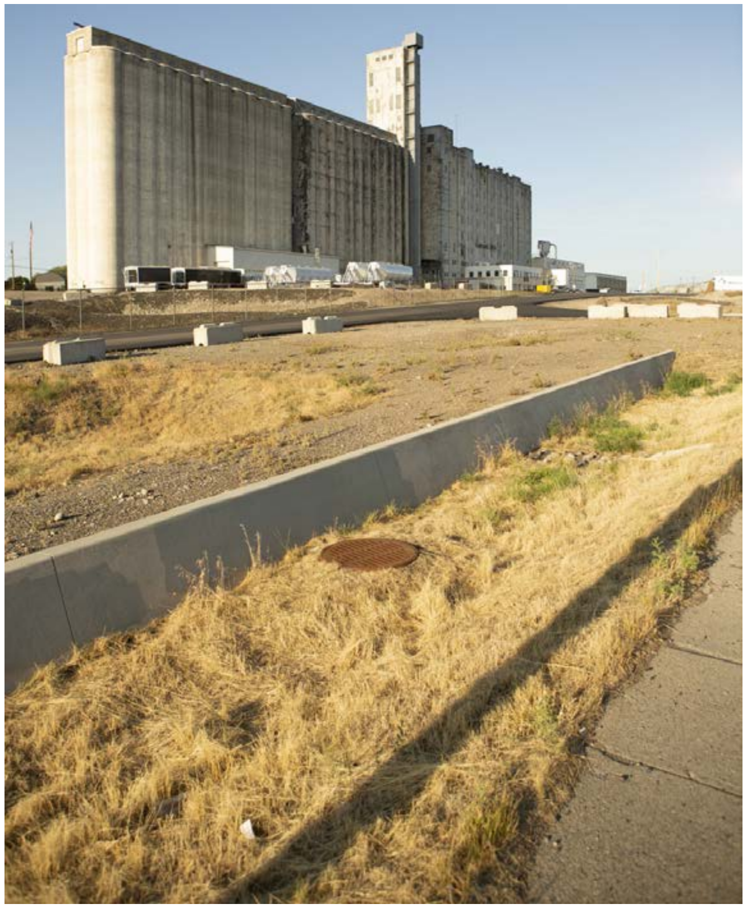

Exhibit 5-11: Bio-infiltration facility in Union Basin near Trent Ave and Crestline Street.

The City has alleged that the Union Basin stormwater mitigation was performed for PCBs alone yet the Union Basin Preliminary Design Report states that *"the Union Basin has been identified as a high contributor of PCBs and other industrial pollutants to the Spokane River"* (City, 2015e, p. 2). The design report goes on to specify required pollutant removal percentages for the project, which has no mention of required PCB removal (Exhibit 5-12; City 2015d).

TSS Removal	80%
Phosphorus Removal	50%
Zinc Removal	60%
Copper Removal	30%
Nitrogen Removal	Not established
Oil & Grease	No visible sheen

Exhibit 5-12: Required Constituent Removal Percentages for Union Basin Stormwater Improvement Project
Source: City, 2015e

The third stormwater facility in the Union Basin is the Erie and Trent Stormwater facility, which contained an identical list of required constituent removal percentages in its design documents (City, 2015e), with required target constituent removal efficiencies for TSS, phosphorus, zinc, copper, nitrogen, and oil and grease, but not PCBs (City, 2015b). Because the soil in the area is contaminated by petroleum, PAHs, and lead, it was deemed not to be suitable for direct infiltration. PCBs were not detected in soil (Budinger & Associates, 2019). Because of the various non-PCB related impacts present in soil, the water from this facility is planned to be stored, and then pumped to a dry well infiltration area for direct infiltration into the groundwater aquifer (Davis, 2015). The City's claimed cost for this project is $563,722.91, the Department of Ecology provided the City with a $1,031,447.50 grant for the implementation of this work. The grant agreement further illustrates that the objective of this facility was for mitigation of general stormwater impacts with the project description:

> "*This project will provide treatment for total suspended solids (TSS), oil (Total Petroleum Hydrocarbons), and dissolved copper and zinc by increasing stormwater infiltration and providing stormwater detention*" (Ecology, 2018a; p.1)

The City has claimed "Ramp Detectable Warning" (Exhibit 5-13) in its costs on many of these public works projects. These bumps at crosswalk curbs for Americans with Disabilities Act (ADA) compliance have nothing to do with mitigation of PCBs (Union Basin; SPOK-SPOKANE-PRR-2212758);

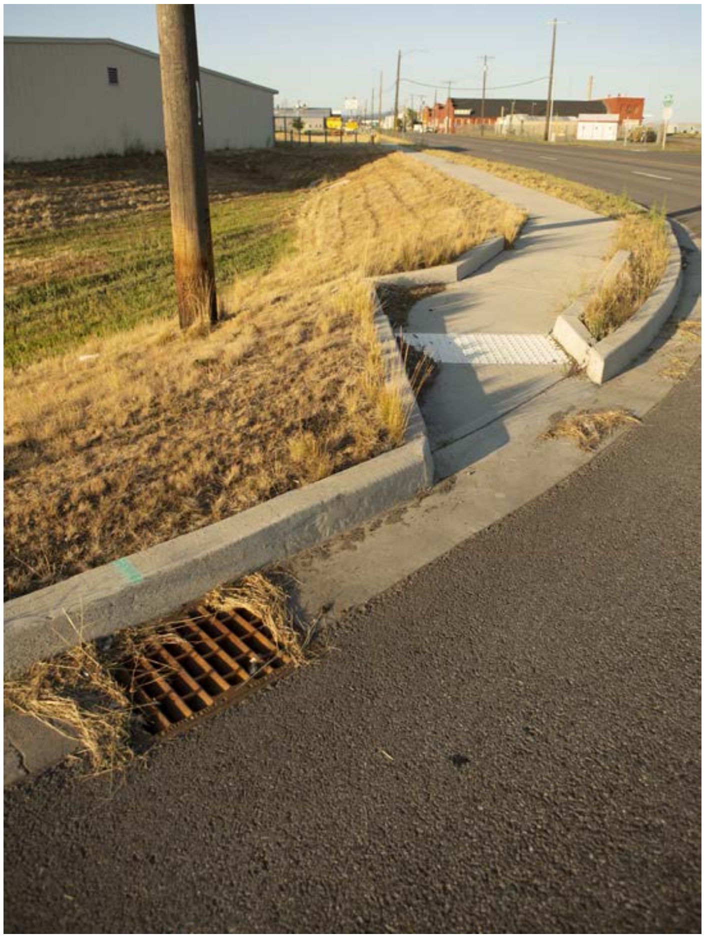

Exhibit 5-13: Examples of "Ramp Detectable Warning" at Trent Road and Regal Street in Union Basin

5.3.12 Indiana Phase 1 and 2

The 2017 "Green Stormwater Evolution" summary states that stormwater was managed as part of the street reconstruction project for 10 blocks of Indiana Avenue, and that the project was undertaken as part of the Integrated Plan to manage stormwater on site whenever a street is rebuilt (Davis and Papich, 2017). Based on the project Charter by the City, the pre-project stormwater management along Indiana Avenue included a mixture of direct infiltration through drywells, discharge to a CSO basin, and portions of a separated MS4 system (Exhibit 5-14).

Exhibit 5-14: Stormwater facilities along Indiana Avenue

The Indiana Avenue Project Charter summarizes the pre-project conditions:

> "*The subject street is in poor physical condition. There is evidence of trolley rails in the center of the street. Storm drainage is presently routed to catch basins piped directly to drywells.*" (City, 2015f, p. 1).

Task 3 of the project is identified as: *Design of storm drainage, incorporating opportunities to separate storm water from the combined sewer overflow system* (City, 2015f, p. 3).

There was no specific testing performed for PCBs, rather this project was implemented as a general BMP for improving stormwater quality.

5.3.13 Summit and Nettleton

This project involves the construction of an infiltration facility to manage stormwater from the newly constructed Kendall Yards development project, using $342,000 in grant funding from an Ecology storm water grant (Exhibit 5-15; City, 2012). A second portion of the project involves a storage and conveyance system which is funded through an Ecology Loan. The conceptual approval of the project describes the construction of Rain

Gardens, Pervious Pathway and Educational Signs, and installation of plants and trees. This project is focused on implementation of LID construction practices to a new development and is not related to PCB impacts. It is rather a BMP for general reduction of stormwater runoff to the Spokane River (City, 2012, p. 226).

Exhibit 5-15: Storm garden and pervious pathway at Summit and Nettleton

The City's project description does not identify PCBs among the numerous stormwater constituents the project is designed to reduce. The City's fact sheet describes the project objectives as:

- The facility is sized to treat a six-month design storm or 150,000 gallons of stormwater
- LID treatment allows for cleaner runoff prior to discharge and reduce the exposure of such elements to humans who have direct contact with the river, and to wildlife and aquatic organisms
- Removes 1.125 lbs of phosphorus per year
- Reduces the accumulation of petroleum products, automotive fluids, metals, nutrients, and solids (City, undated fact sheet).

The fact sheet for the stormwater project contains no mention of PCB removal as a specific project goal, and no aspect of this project is designed specifically for PCB removal.

- The rock landscaping honoring the Olmstead Brothers at Summit and Nettleton has no relationship to controlling PCBs, yet has been included in the City's claimed costs for the RPWRF facility (City 30(b)(6), Davis, 2019a, 214-215[34]) (Exhibit 5-15; SPOKANE-PRR-2616830);

Park benches at Summit and Nettleton have no relation to PCB mitigation but were included in the City's claimed costs for this project. (Exhibit 5-16; SPOKANE-PRR-2616830) (City 30(b)(6) Davis, 2019a, 216-218)[35]

[34] Q. Oh, I'm sorry. I thought it was a reinforced concrete retaining wall.
A. Well, it is that with the basalt on the exterior and also there's basalt ledges. So it's a combination of the retaining wall and the basalt at this facility.
Q. I guess my question is, what added functionality does the basalt veneer have to a concrete retaining wall? Isn't the concrete strong enough to retain stormwater?
A. Yes. But it doesn't match the character and intent of the park.
Q. So it's aesthetics?
A. You could say aesthetics, aesthetics or neighborhood, matching the neighborhood character.

[35] Q. (BY MR. GOUTMAN:) It also includes benches -- a bench and interpretive signs. Is that correct?
A. Yes, it does have a bench and interpretive signs.
Q. Well, it has three benches at $4,000 each. Correct?
A. Right. It has benches. The interpretive signs were for stormwater education.
Q. I see. So...
Q. I'm showing you a photograph which I've marked as Exhibit 37. Is that the interpretive sign?
A. Yes.
Q. Does it have anything to do with the normal functioning of a stormwater BMP, which would be preventing -- let me ask it this way: Does this sign retain or store stormwater?
A. No.
Q. Does it direct stormwater away from the Spokane River?
A. No.
Q. Does it prevent any constituent from entering the Spokane River?
MR. LAND: Objection. Vague.
THE WITNESS: Possibly.
Q. How is that? Do you think that the constituents would adhere to the sign?
A. No. It would not.
Q. How does it capture the constituents?
A. It would not.

Exhibit 5-16: Park Bench at Summit and Nettleton

5.3.14 RPWRF LID

The RPWRF LID project goal is to rehabilitate the facility's parking lot and exterior landscaping with permeable concrete unit pavers, porous grass pavers, porous concrete sidewalks, and bioretention swales adjacent to the Aubrey L White Parkway (Exhibit 5-17; Ecology, 2016c). In 2015 the City was awarded an Ecology stormwater grant for $347,625 with a required 25% match ($115,875), which totaled the initial budget to $463,500; however, the project was completed in May 2016 and the final project cost was $270,000 and of that total, Ecology's contribution was $202,500 (Ecology, 2016c). The overall goal of the project is to use infiltration to treat and minimize runoff to the river which will help meet water quality and quantity requirements of the Spokane Regional Stormwater Manual (Spokane County, City of Spokane, and City of Spokane Valley, 2008). Similar to other City LID projects, there is no aspect of this project that is specifically designed to remove PCBs.

Exhibit 5-17: The RPWRF LID and stormwater facilities, with water feature

The following items have no relationship to controlling PCBs, yet have been included in the City's claimed costs for the RPWRF facility:

- Wave screen panels (City 30(b)(6), Davis, 2019a, 170[36]), water features (City 30(b)(6) Davis, 2019a 171[37]), and fire protection system (City 30(b)(6), Davis, 2019a, 172[38]) at the RPWRF (Exhibit 5-17 and Exhibit 5-18);

[36] Q. Can you tell me the stormwater management function of those wave screen panels, which were billed at $150,000?
A. No, I can't.

[37] Q. This will be 27. This is the water feature which was billed at 58,000, according to the previous exhibit, or two exhibits ago, the bill. What is the stormwater management function of this water feature?
A. I don't know of a stormwater management function of that.

[38] Q. And then it says "fire protection," which includes submittals in design, painting, material installation, tests, and inspection to the tune of $193,000 for the Riverside facility. What stormwater management function do these items have? I don't know what their stormwater management function would be.

Exhibit 5-18: The RPWRF LID and wave screen panels

5.3.15 Finch Arboretum LID

Finch Arboretum LID Project is a bioinfiltration facility incorporated into the parking lot that includes permeable pavement of the Woodland Center, John A. Finch Arboretum and was completed in October 2015. The goal of the project is to improve the water quality of Garden Springs Creek, demonstrate permeable pavement, and to provide education about using trees in LID projects. The project is funded through an Ecology Stormwater Grant of $99,600 with a 25% match required by the City, totaling to a budget of $132,000. The project's main components are stormwater retrofits that include rerouting the MS4 pipe in F Street under the parking lot area to discharge into a bioinfiltration facility located to the northwest of the parking lot, a permeable pavement parking lot adjacent to the Woodland Center, and educational signs. The 2013 Preliminary Design states that the project is anticipated to annually remove 64.61 lbs of TSS, 0.0045 lbs of copper, 0.023 lbs of zinc, and 0.11 lbs of phosphorus from Garden Springs Creek (City, 2013).

As stated in the 2013 Preliminary Design report, the existing parking lot is in *"fair condition"* and the *"lot does not provide sufficient parking for events that are held at the Arboretum"* and during events the existing parking lot makes the *"Arboretum a less attractive venue for these events*" (City, 2013, p. 2 - 3). The City used funds to create a larger parking lot with permeable pavement and to re-route a portion of stormwater from

the original parking lot and adjacent street to a grassy infiltration area (Exhibit 5-19). No component of the attributable work or retrofit specifically addresses PCBs, which have never been sampled or identified as a constituent in runoff from this arboretum, located in a residential neighborhood.

Exhibit 5-19: Finch Arboretum- Expanded parking area with pervious pavement on the left half of the parking area

Some of the City's claimed line items are small, but where projected across many projects, add to significant costs that are in no way related to stormwater quality, such as "Pavement Marking, Durable Inlay Tape" (Exhibit 5-20) (Finch LID, SPOKANE-PRR-2616591);

Exhibit 5-20: Pavement Marking, Durable Inlay Tape at the Finch Arboretum LID parking lot

5.3.16 Pettet Drive

Pettet Drive MS4 Elimination project provides stormwater management in 3,500 feet of Pettet Drive between Nora Street and east of the TJ Meenach Bridge using bioretention swales adjacent to Pettet Drive, permeable pavement, tree features, and a permanent educational sign (Exhibit 5-21; City, 2014a; Ecology, 2016b). The previously existing stormwater control consisted of several catch basins draining into a 12-inch pipe that drained directly to the Spokane River. The new project used the existing collection system to direct runoff to the new bioretention areas and eliminated the outfall (City, 2014a). In 2015, Ecology awarded the City a grant of $450,000 for the Pettet MS4 Elimination project (Ecology, 2016b). The 2016 Financial Agreement states that the expected outcome of the project will provide water quality benefits that include reductions in CBOD, total phosphorus, ammonia, nitrogen, cadmium, lead, zinc, and PCBs. The overall project reduces direct discharge of all stormwater runoff and does not include any infrastructure specific to PCBs.

Exhibit 5-21: Example of one bioretention area along Pettet Drive

5.3.17 Washington Basin

Washington Basin stormwater improvements were constructed with approximately $2.45 million in grant funding, in conjunction with the portions of the Monroe Street improvement project. The street project provided stub out locations within the Washington basin. The stormwater portion of this project constructed treatment and disposal facilities at each of the stub out locations (Exhibit 5-22) (City, 2018b), none of which were specifically to address PCBs. The BMPs are not uniquely designed for removal of PCBs but are rather general best practices for stormwater management.

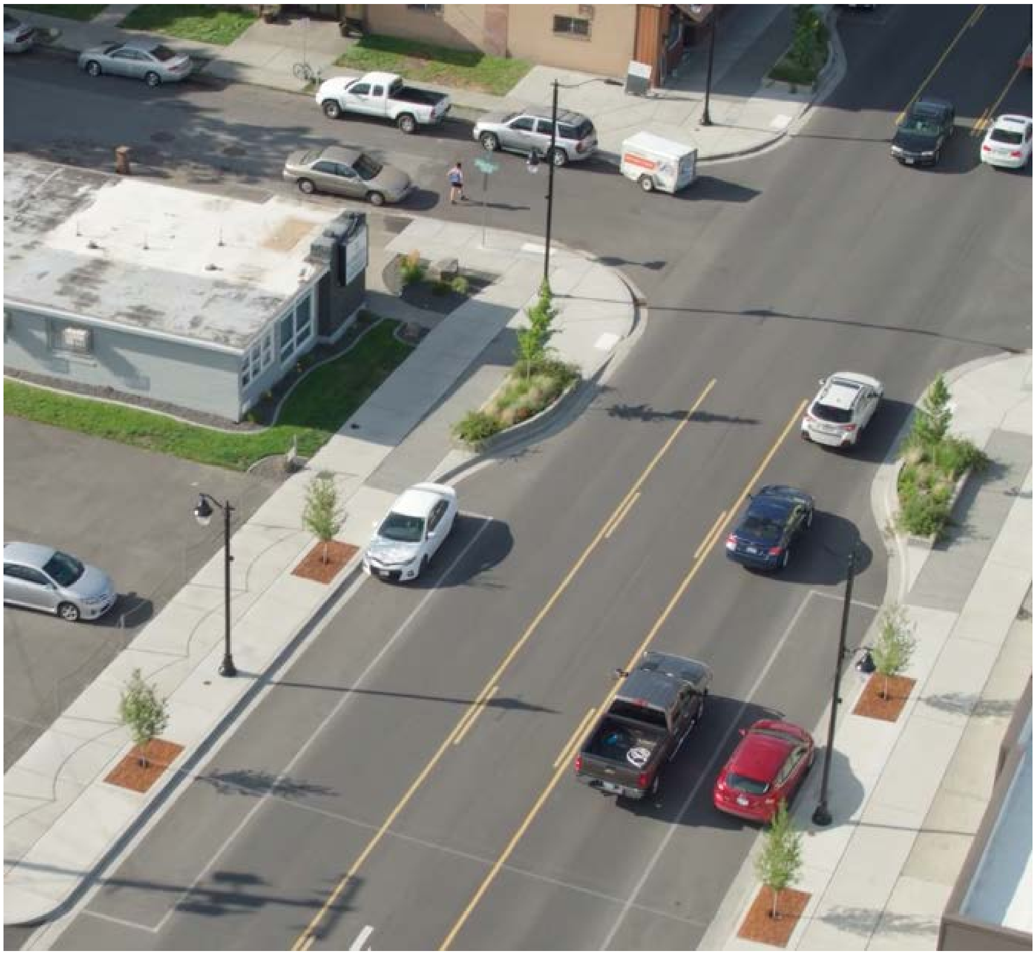

Exhibit 5-22: Example of Washington basin treatment and disposal facilities at stub out locations along Monroe Street

5.3.18 North Monroe

The North Monroe project as described on the City website states:

> "*The project includes reconfiguring the street from five traffic lanes to three lanes, accommodating wider driving lanes, enhanced on-street parking, and wider sidewalks. Other improvements include enhanced lighting, curb bump-outs at intersections that allow for shorter crossing distances, and three crosswalk flashing beacons*"[39]

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[39] https://my.spokanecity.org/projects/north-monroe-corridor/

There is no mention of PCBs in the City's limited project documentation. The Capital Improvement Plan simply states:

> "*This project is intended to improve safety for pedestrians and cyclist by reducing road and lane width and providing a wider sidewalk. Infrastructure renewal of water main that is over 100 years old. As part of the street project, stormwater will be treated and infiltrated instead of being discharged directly to the Spokane River.*" (City, 2016d, p. 984).

The BMPs are general practices for stormwater management unrelated to the presence of any specific constituent, much less PCBBs. Some of the claimed project costs are purely aesthetic, such as decorative boulders of basalt (Exhibit 5-23), (PCB-SPOKANE-08119245).

Exhibit 5-23: Decorative boulders at North Monroe

5.3.19 Rowan Avenue

Rowan Ave was classified as a Streets - Capital Improvement project in the 2016-2021 and 2017-2022 Citywide Capital Improvement Plans (City, 2015g; City, 2016d). The executive summaries in the plans state that the project will include *"Pave roadway to full depth. Repurpose roadway with two 11-foot travel lanes and bike lanes from Driscoll to F St. and two 11.5'-foot travel lanes and bike lanes from F St. to Alberta St. and remove parking. Swales will be built on Driscoll to collect stormwater. Integrated with water and*

Stormwater" and the project justifications state *"this section of road is deteriorating and needs repair. Reduction of MS4 stormwater flow will be achieved through bypass to swales"* (City, 2016d, p. 995). Stormwater is a small portion of the integrated project and the BMPs are not designed for removal of PCBs, but rather are general best practices for stormwater management (Exhibit 5-24).

Exhibit 5-24: Swales and stormwater facilities along Driscoll Ave, near Rowan Avenue

5.3.20 Summary

The City has taken many actions to mitigate the volume of stormwater discharges to the combined sewer system. These actions are an essential part of the City's CSO control strategy, as required by the City's NPDES permit for CSOs and the RPWRF Facility and are unrelated to the absence or presence of PCBs in the Spokane River or in stormwater. In MS4 stormwater basins, the City stormwater project actions are an integral part of the City's best management practices for control of conventional stormwater constituents other than total PCBs, pursuant to the City's TMDL and NPDES obligations, and are not increased in cost or scope due to the presence of PCBs. In many cases, the City has collected no samples to even determine if PCBs are present. A summary of the City's past and projected future cost claims related to these projects are presented in Exhibits 5-25 and 5-26. A large portion of both CSO and MS4 basin stormwater projects have also been

EXHIBIT 5-25
Summary of the City's Past Cost Claims for Stormwater Projects

Name of Improvement	Description and Purpose	Claimed Costs	Grant Funding
Union Basin Stormwater Improvements	Collective of MS4 projects to reduce stormwater discharge and improve water quality within Union Basin unrelated to PCBs	$ 1,142,285.12	$ 1,000,000.00
Erie and Trent Stormwater	MS4 projects including infiltration to reduce overflow frequency from CSO 34 and improve stormwater quality unrelated to PCBs	$ 563,722.91	$ 1,031,447.50
Indiana Ph 1	Road and infrastructure improvement projects incorporating MS4 retrofits to separate storwamter from the CSO system unrelated to PCBs	$ 392,765.84	$ -
Indiana Ph 2	Road and infrastructure improvement projects incorporating MS4 retrofits to separate storwamter from the CSO system unrelated to PCBs	$ 531,952.35	$ -
North Monroe [Monroe Street Stormwater (Washington Basin)][1]	Road and infrastructure improvement projects incorporating stormwater infiltration projects to reduce stormwater discharge and improve water quality unrelated to PCBs	$ 1,894,127.68	$ 2,455,500.00
Pacific & Perry Stormwater Facility	Separation and reconnection of CSO 33c to bioinfiltration areas to reduce or eliminate CSO discharge and improve water quality unrelated to PCBs	$ 1,401,539.37	$ 1,037,362.00
Summit Nettleton Infiltration Facility	Infiltration and evaporation using LID practices at Olmstead Brothers Park to reduce stormwater discharge and improve water quality unrelated to PCBs	$ 565,025.57	$ 342,000.00
West Broadway SURGE	Green infrastructure including pervious pavement to reduce frequency of overflow from the CSO 23 basin unrelated to PCBs	$ 526,655.33	$ -
RPWRF LID (Parking Lot)	LID, porous pavement, infiltration, and treatment of stormwater to reduce stormwater runoff and improve water quality unrelated to PCBs	$ 1,239,162.75	$ 347,625.00
River Runoff Reduction	Drywells on residential streets to reduce stormwater volume and improve water quality unrelated to PCBs	$ 1,862,489.20	$ -
Finch LID (Arboretum)	LID and bioinfiltration incorporated into a parking lot that has permeable pavement to reduce discharge to the MS4 at Finch Arboretum unrelated to PCBs	$ 270,333.32	$ 99,600.00
Pettet Drive (MS4)	Construction of bioretention facilities along Pettet Drive between Nora Street and east of TJ Meenach Bridge to reduce stormwater volume and improve water quality unrelated to PCBs	$ 1,533,169.62	$ 450,000.00
Rowan Ave	Construction of swales to direct stormwater as part of streets capital improvements concurrent with road repair to reduce stormwater runoff unrelated to PCBs	$ 420,742.59	$ -
Peaceful Valley	Construction of storage facility to limit overflows from CSO 22b basin, unrelated to PCBs	$ 2,417.73	$ -
South Gorge Project	Construction of bioretention facilities as part of trail restoration activities in the CSO 22b/25 basin to reduce CSO discharge frequency unrelated to PCBs	$ 2,737.00	$ -
Cochran Basin RRR	MS4 project to reduce stormwater runoff volume and improve water quality unrelated to PCBs	$ 1,040,576.83	$ 5,100,000.00
Cochran Basin - Boat Launch[2]	MS4 project to reduce stormwater runoff volume and improve water quality unrelated to PCBs	$ 1,828.68	
Cochran Basin - Piping TJ Meenach River to NW Blvd[2]	MS4 project to reduce stormwater runoff volume and improve water quality unrelated to PCBs	$ 257.22	$ 13,752,115.00
Cochran Basin - Piping TJ Meenach to Downriver[2]	MS4 project to reduce stormwater runoff volume and improve water quality unrelated to PCBs	$ 3,257.74	
Sharp Ave	Research opportunity on pervious pavement as LID technology, bioinfiltration facilities to reduce stormwater runoff and improve water quality unrelated to PCBs	$ 3,385,397.93	$ 1,260,000.00
High Drive 20140506	Construction of infiltration facilities and other GI within the CSO 20 and 24 basin; retrofit existing stormwater/wastewater conveyance infrastructure to reduce CSO discharge frequency unrelated to PCBs	$ 515,165.52	$ -
High Drive 29th to Bernard		$ 1,093,031.04	$ 242,000.00
High Drive 2015127		$ 903,851.02	$ -
East Central Stormwater Improvement	Collective of orphan projects inlcuding sewer separation and GI from several CSO mitigation projects within the CSO 33 basin to reduce CSO discharge frequency, unrelated to PCBs	$ 1,895,523.15	$ -
Washington Stormwater Basin (Monroe Street Stormwater Improvement)	Stormwater treatment and disposal facilities (bioinfiltration swales) to reduce stormwater runoff and improve water quality, unrelated to PCBs	$ 84,806.76	$ -

Notes:
MS4 - Municipal separated stormwater system
CSO - Combined sewer overflow
PCB- Polychlorinated biphenyl
LID - Low impact development
[1] Grant Funding is the sum of Monroe Street Stormwater (Washington Basin) and Lincoln/Monroe Stormwater (City, 2019a; Appendix B).
[2] Grant Funding is the sum of Cochran Conveyance, Cochran Disc Golf, TJ Meenach, TJ Meenach - design, and Cochran Basin Conveyance Piping (City, 2019a; Appendix B).

Reference:
City, 2019a. Plaintiff's Third Supplement to Plaintiff's Second Amended Objections and Responses to Pharmacia LLC's First Amended Special Interrogatories 1 July, 2019

EXHIBIT 5-26
Summary of City's Projected Future Cost Claims for Stormwater Projects

Name of Improvement	Description and Purpose	Claimed Costs	Grant Funding
Erie Stormwater Facility (Future)	MS4 projects including infiltration to reduce overflow frequency from CSO 34 and improve stormwater quality.	$ 2,214,967.00	$ 1,031,477.00
Pacific & Perry Stormwater Facility (Future)	Separation and reconnection of CSO 33c to bioinfiltration areas to reduce or eliminate CSO discharge and improve water quality unrelated to PCBs	$ 3,257,521.00	$ 778,021.00
Peaceful Valley Stormwater Separation (Future)	Construction of storage facility to limit overflows from CSO 22b basin, unrelated to PCBs	$ 1,920,000.00	$ 840,348.00
South Gorge Trail Stormwater Project (Future)	Construction of bioretention facilities as part of trail restoration activities in the CSO 22b/25 basin to reduce CSO discharge frequency unrelated to PCBs	$ 395,000.00	$ -
Cochran Basin Conveyance Pipeline, TJ Meenach to Downriver (Future)	Future cost - MS4 project to reduce stormwater runoff volume and improve water quality unrelated to PCBs	$ 7,730,000.00	$ 5,934,000.00
Cochran Basin Lift Station and Control Facility (Future)	Future cost - MS4 project to reduce stormwater runoff volume and improve water quality unrelated to PCBs	$ 6,633,000.00	$ 4,975,000.00
Cochran Basin Stormwater Piping TJ Meenach to NW Blvd (Future)	Future cost - MS4 project to reduce stormwater runoff volume and improve water quality unrelated to PCBs	$ 3,280,000.00	$ 2,479,000.00
Cochran Basin Treatment Facility - Downriver Boat Launch (Future)	Future cost - MS4 project to reduce stormwater runoff volume and improve water quality unrelated to PCBs	$ 2,296,000.00	$ 1,721,000.00
Cochran Basin Treatment Facility - Downriver Disc Golf Course (Future)	Future cost - MS4 project to reduce stormwater runoff volume and improve water quality unrelated to PCBs	$ 4,645,000.00	$ 3,166,500.00
Washington Basin Stormwater Project (Monroe Street Stormwater Improvement) (Future)	Stormwater treatment and disposal facilities (bioinfiltration swales) to reduce stormwater runoff and improve water quality, unrelated to PCBs	$ 3,000,000.00	$ 2,275,200.00
Spokane Falls Blvd.- Post to Division (Future)	Minimize stormwater runoff into the future CSO 26 CSO control facility to reduce CSO discharge frequency unrelated to PCBs	$ 140,000.00	$ 54,000.00
Sprague Ave - Bernard to Scott (Future)	Future Cost	$ 1,614,232.00	$ -
WSDOT-I90 stormwater separation (Future)	Future plans for diversion of stormwater from CSO basin 34 to reduce CSO discharge frequency unrelated to PCBs	$ 250,000.00	$ 250,000.00

Notes:
MS4 - Municipal separated stormwater system
CSO - Combined sewer overflow
PCB- Polychlorinated biphenyl
Reference:
City, 2019a. Plaintiff’s Third Supplement to Plaintiff’s Second Amended Objections and Responses to Pharmacia LLC’s First Amended Special Interrogatories 1 July, 2019

funded by grants. Nonetheless, it is my understanding that the City is also seeking reimbursement for the costs that were paid for by grant funds (City 30(b)(6), Davis, 2019b, 278-279). It is my opinion that none of these stormwater and CSO projects are attributable to PCBs, and that none of these actions would be any different, had PCBs never been invented.

6. OPINION 5: THE SPOKANE RIVER CURRENTLY COMPLIES WITH THE APPLICABLE WATER QUALITY CRITERION FOR PCBS. THERE IS NO REGULATORY REQUIREMENT FOR THE CITY TO TAKE ANY ACTION TO REDUCE PCB DISCHARGES FROM THE STORM WATER OR WASTEWATER SYSTEMS.

In 2017, Mayor Condon wrote a letter petitioning the USEPA to return the Washington surface water criterion to the 170 parts per quadrillion (ppq) standard originally proposed by Ecology, a concentration the City believes to be protective of its citizens:

> "*over the past several years, the City has supported Ecology's process to update the Water Quality Standards for Protecting Human Health (fish consumption rates) as found in Chapter 173-10 I A of the Washington Administrative Code (WAC). Ecology worked hard to develop a thoughtful water quality rule, with PCHs set at 170 ppq, based on sound science in order to protect human health.*" (Condon, 2017, p. 1)

In May 2019, USEPA concurred with Mayor Condon and re-established Ecology's standard of 170 ppq as the surface water PCB standard for the State of Washington (Code of Federal Regulations (CFR) Vol 84, No 151, 2019). The Spokane River has consistently met this standard in every synoptic survey of water quality performed by the SRRTTF (LimnoTech, 2015; LimnoTech, 2016, LimnoTech, 2019). In 2014, 2015, and 2016 monitoring events, average concentrations of PCBs at all stations in the Spokane River showed compliance with the Washington State water quality standard of 170 ppq (Coster, 2019, p.23-24)[40]

This trend has continued through to the recent 2019 synoptic sampling of the Spokane River (LimnoTech, 2019), where the City reported that the average concentrations of PCBs show compliance with the state water quality standard of 170 ppq, with the exceptions of two samples that were identified as laboratory error (City 30(b)(6) Hendron,

[40]Q. And then I'd like you to read that next sentence after "Mile Dam" starting with the word "Average." If you'll just read that aloud, please. Sorry.
A: "Average concentrations at all stations show compliance with the current Washington State water quality standard of 170 picograms per liter."
Q: Right. And that is what was reported in this document based on sampling events conducted by the task force in 2014, 2015, and 2016; correct?
A: Correct.

2019 p.304)[41]. Plaintiff's experts Trapp (Trapp and Bowdan, 2019, p. 28) and Coughlan (Coughlan, 2019, p. 45) both admit that the river complies with the 170 ppq standard.

There is no current numeric limit for PCB discharges from the RPWRF. The City commented on the 2016 draft RPWRF NPDES discharge permit, stating that the current PCB concentration in the river meets the Washington State standard:

> "*the reasonable potential analysis (RPA) discussed on page 37 of the Fact Sheet (and calculated on page 83), indicates that RPWRF does not have the reasonable potential to cause an exceedance of the water quality standard for PCBs…The City would point out that based on PCB monitoring conducted by SRRTTF in 2014-2016, the Spokane River appears to be actually below the water quality criteria of 170 pg/L on an annual average basis.*" (City, 2016b, p. 3).

Similarly, there is no numeric limit for PCB discharges in the City's stormwater permit. The City's anticipation of a future numeric TMDL is purely speculative.

[41] Q: So once again in – as of February 20, 2019, the Spokane River PCBs concentrations are less than 170 ppq?
A: Based on these cites, yes.
Q: Are you aware of any test data that would suggest that average concentrations are greater than 170?
A: No.

7. OPINION 6: THE MASS OF PCBS CURRENTLY BEING DISCHARGED FROM CITY'S STORM WATER AND WASTEWATER SYSTEMS IS *DE MINIMIS* AND WILL NOT MATERIALLY AFFECT THE SPOKANE RIVER'S WATER QUALITY.

The annual mass of PCBs being discharged from the City's MS4s, CSOs and the RPWRF are a small fraction of the total PCBs contributed by other sources and will not affect the Spokane River's water quality.

As estimated by the Plaintiff's expert, Dilks (2019), current PCB loads from the City's discharges (2014-2018) are demonstrably small. By Dilks' estimate, PCB loads from the City's MS4s, CSOs, and the RPWRF are 0.0013 ounces/day, 0.0002 ounces/day, and 0.0027 ounces/day, respectively. These discharges amount to a *de minimis* portion of the total PCB load to the river which is 0.0681 ounces/day (Dilks, 2019). The remaining 0.0640 ounces/day of the PCB load is dominated by PCBs flowing towards the City from upstream of the City limits, including sources from upstream of the Idaho border, industrial discharges from Kaiser, and Kaiser groundwater PCB discharges (Exhibit 7-1). Thus, the annual discharge from all City related sources, is de minimis compared to the overall PCB load to the River. The vast majority of the PCB load in the river is beyond the control of the City.

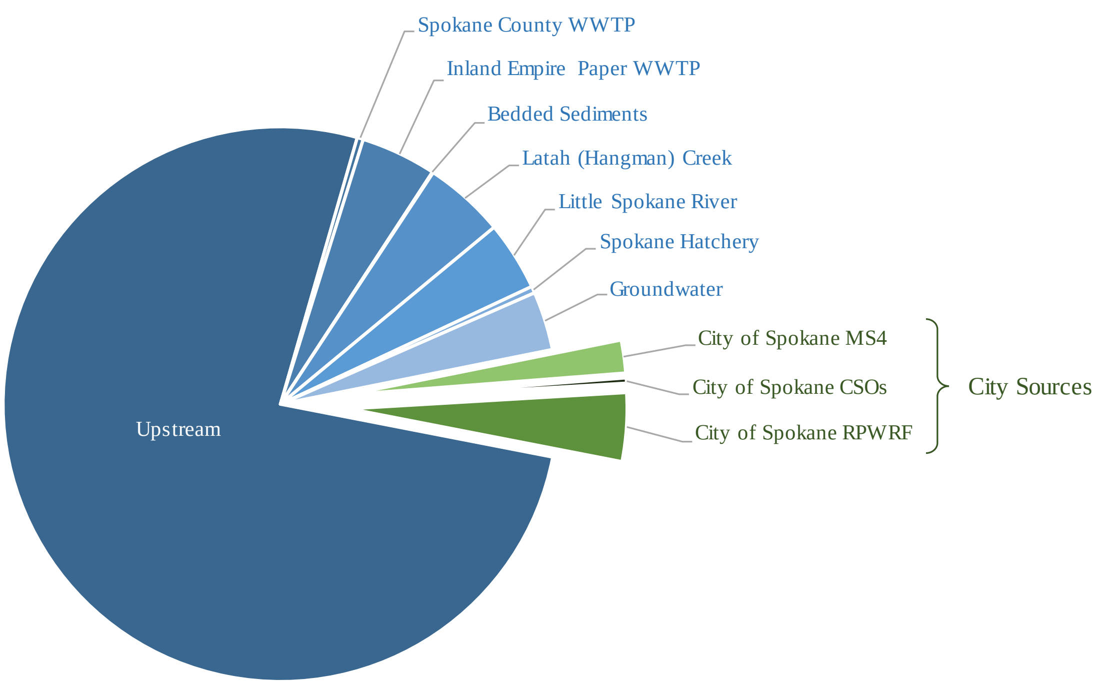

Exhibit 7-1. The vast majority of PCB loading in the Spokane River is outside the control of the City of Spokane
Source: Dilks, 2019-Table 1

This total PCB load in the river of 0.0681 ounces/day stands in stark contrast to the estimated metals loading to the Spokane River, flowing out of Lake Coeur D'Alene. The average loading of cadmium, lead, and zinc to the Spokane river from 1991-2013 is estimated to be 14.7 lbs/day, 104 lbs/day, and 2,397 lbs/day, respectively based on the metals loading at the Post Falls station (USGS, 2006; USGS, 2014).

As discussed in Opinion 5, PCB concentrations in the Spokane River do not exceed the State's PCB water quality criterion of 170 ppq. Even the complete elimination of the City's stormwater and wastewater PCB load will not measurably change the water quality of the river. In other words, the reduction of a *de minimis* PCB load to the Spokane River will in turn have no measurable impact on the river's water quality, as discussed in Opinion 8.

8. OPINION 7: DR. TRAPP PROPOSES A STORMWATER CAPTURE ALTERNATIVE WHICH IS UNPRECEDENTED, INFEASIBLE, UNREASONABLE, IS NOT REQUIRED UNDER THE CITY'S STORMWATER MANAGEMENT PERMIT, AND SEEKS REDUNDANT COSTS ALREADY CLAIMED BY THE CITY.

Trapp's fundamental lack of understanding of the source of PCBs within the Spokane River system invalidates his conclusions regarding the necessity of stormwater capture and treatment. Trapp has concluded that City stormwater is a major source of PCBs to the Spokane River. He comes to this conclusion based on old data in a 2003-2007 Ecology study (Serdar et al., 2011). This outdated study concludes that stormwater contributes 44% of PCB loads to the Washington reaches of the River. Trapp uses this study as the basis of his opinion that stormwater is a major source of PCBs to the River.

Trapp ignores the recent study by Plaintiff's expert Dilks who examined PCB sources to the river (Dilks, 2019; Limnotech, 2016). Dilks concluded that only 1.9% of the PCB load in the river is attributable to City stormwater sources (Dilks, 2019, Table 1) (Exhibit 8-1). Dilks' estimate that 2.2% of PCBs originate from the stormwater/CSO system (0.0015 ounces/day) demonstrates that City stormwater/CSO discharges contribute a de minimis portion of the current overall PCB river load.

	2019 Dilks Source Assessment	Trapp Alleged Source Distribution
Upstream Sources	76%	30%
City Stormwater	1.9%	44%
City CSO	0.3%	(Included in City Stormwater)
Industrial/Municipal wastewater Discharges	8.7%	20%
Groundwater	3.4%	-
Other Sources	9.2%	6%

Exhibit 8-1: Comparison of current PCB source assessments from Plaintiffs experts Dilks, 2019 – Trapp, 2019

Source: Dilks, 2019; Trapp, 2019

Based on his erroneous conclusion that stormwater is a major source of PCB loading to the Spokane River, Dr. Trapp presents the argument that the complete capture and infiltration of all stormwater is required to comply with the previously applicable 7 ppq surface water standard (the current standard is 170 ppq).

Dr. Trapp's plan would have no measurable effect on river water quality

Trapp has estimated that stormwater from his 12 modeled basins annually transports approximately 13.5 grams (0.48 ounces) of PCBs, which is less than 2% of the current annual river PCB load of 705 grams (24.7 ounces) according to the estimate provided by Dilks. Plaintiff expert Coughlan presents that the average concentration of the river (2014-2016) as measured at 9-mile dam was 132 ppq, meeting the current surface water standard of 170 ppq. Based on Trapp's estimated current PCB mass loading from MS4s to the Spokane River (0.0013 ounces/day in 2018; Trapp and Bowdan, 2019, Table 7) and using the average annual volume of water flowing in the river through the City in the same 2014-2016 time period (5,194 billion liters per year) [42], stormwater discharges are estimated to comprise approximately 2.63 ppq (less than 2%) of the river's total PCB load. In comparison, the average concentration of PCBs found in laboratory blank contamination by Plaintiff's expert Rodenburg was 88 ppq (Rodenburg, 2019a). With laboratory blank contamination variability that introduces more than 30 times more total PCBs to collected samples than the 2.63 ppq expected load reduction from complete stormwater removal, the change in river concentration from Dr. Trapp's plan could not even be reliably measured with today's technology.

Dr. Trapp's most conservative Scenario 1 is estimated to cost over $150 million more than the least conservative Scenario 2, while capturing only 0.0005 additional ounces of PCBs each year. This would result in no measurable difference in river PCB concentration between Scenario 1 and Scenario 2, for an incremental cost of over $300 Billion per ounce removed. This is not a credible or reasonable alternative.

Dr. Trapp's stormwater capture scenarios are unreasonable

Dr. Trapp's extreme remedial Scenario 1 is premised on the assumption that the City will need to capture 100% of stormwater to comply with the City's permit conditions[43]. The City's permit has no such requirement. This is not a credible or feasible alternative to be implemented in Spokane. The permit only requires the implementation of AKART BMPs. Dr. Trapp does not assess the feasibility of his proposal anywhere in his report,

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[42] https://waterdata.usgs.gov/wa/nwis/uv?site_no=12422500

[43] Even though Dr. Trapp's Scenario 1 proposal is premised on 100% control of stormwater, his proposed approach actually only controls stormwater within the City's 12 largest MS4 basins, while proposing to allow the remaining 118 storm water basins to go without treatment. Dr. Trapp has stated that the remaining 118 stormwater basins are left out of his analysis because they only account for 15% of the City's MS4 system and by his estimation, have relatively minimal contribution to stormwater loads in comparison to the larger basins. However, Dr. Trapp has no basis from which to assess the amount of PCB load from these storm water basins as actual PCB concentration data in stormwater have only been collected from 3 of the 130 stormwater basins in the City.

including obvious questions about down-stream water rights related to removal of stormwater flows to the river, land acquisition, and engineering concerns such as spatially variable infiltration rates.

Dr. Trapp suggests capturing 100% of stormwater in 12 basins which account for 85% of stormwater entering the river. This is not reasonable, as a review of the current practice of stormwater management by my staff has shown no instance of communities in Washington State or elsewhere in the US implementing complete stormwater capture over similar areas. (City of Seattle, 2019; City of Tacoma, 2019; City of Bellevue, 2012; City of Vancouver, 2019; City of Grand Rapids, 2014; City of Boise, 2019).

The standard BMPs which the City is already implementing for the control of phosphorus, nitrates, metals, suspended sediment, bacteria, and PAHs, represent the standard AKART measures commonly employed to comply with stormwater BMP requirements. No aspect of any City BMP is specifically designed to mitigate PCBs (City 30(b)(6), Davis, 2019a, 101:18 – 102:6).

Dr. Trapp's Plan is inconsistent with existing City plans and seeks redundant costs.

Dr. Trapp claims that it is unrealistic to assume that stormwater control could be achieved through one large infiltration project in each basin. However, that is exactly what the City has already planned in the Cochran basin, its largest MS4 basin, which contributes approximately 50% of City stormwater to the River (City 30(b)(6), Davis, 2019a, 175:13-16). The City has planned and designed that project and has claimed as damages approximately $25.5 Million in past stormwater costs related to its completion. Trapp ignores the City's existing plan for Cochran basin, and instead claims redundant damages of $161,418,015 in hypothetical stormwater infiltration basins throughout the Cochran Basin. Trapp's estimate to infiltrate all stormwater from Cochran basin costs over six times more than the City's project design for its single infiltration site. Even comparing Trapp's scenario 2, to capture a one-inch storm, his cost estimate is four times greater. The Spokane River currently meets the water quality standard of 170 ppq and no further stormwater reductions are required to ensure that the goal is maintained.

Dr. Trapp's assumptions result in overestimation of PCBs in City stormwater.

In his analysis, Trapp has assumed the Cochran basin runoff is representative of seven of the 12 other stormwater basins based on a comparison of land use (Exhibit 8-2). However, this methodology is flawed, as six of these seven basins have a significantly smaller proportion of commercial and industrial land use types which will impact both the quantity and quality of stormwater runoff from each basin. Trapp provides no basis for his opinion that such varied land use distributions would result in similar runoff quality.

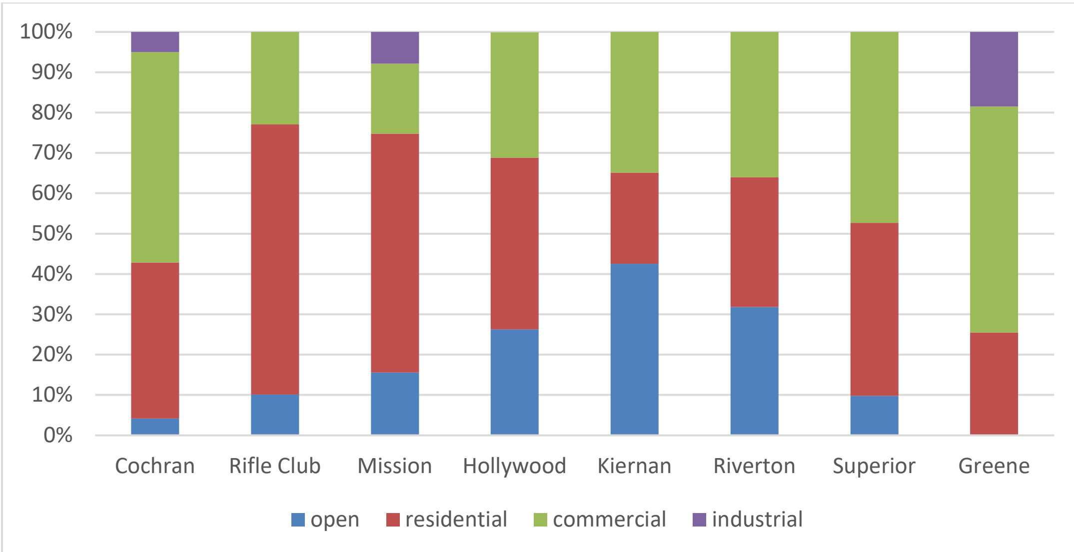

Exhibit 8-2: Land use distribution within basins assumed to be equivalent to Cochran by Trapp

Source: Trapp and Bowdan, 2019 - Table 5

9. OPINION 8. MR. BOWDAN'S CLAIM THAT FUTURE COSTS TO OPERATE AND MAINTAIN THE UPGRADED WASTEWATER TREATMENT PLANT IN THE NON-CRITICAL SEASON ARE REQUIRED DUE TO PCBS HAS NO BASIS IN FACT AND THE CITY HAS ADMITTED THAT THESE COSTS ARE UNRELATED TO PCBS.

None of the costs to operate and maintain the NLT during the non-critical season are related to actions that are specifically designed for removal of PCBs. Bowdan admits in his opinion 2.6 that the operation of the NLT during the non-critical season (November through February) is due to a "net environmental benefit analysis" to reduce overall discharges to the river of a range of constituents, as presented in the City's Integrated Plan (Trapp and Bowden, 2019, p. 49-51).

Bowdan claims that the City will incur ongoing Operations and Maintenance (O&M) costs for operating the NLT through the non-critical season to maintain maximum PCB removal. PCBs represent a *de minimis* fraction of constituents removed by the NLT during the non-critical season (Exhibit 9-1).

Additional Pollutant Load Removed Due to Operating Membrane Filters during the Non-Critical Season

Pollutant	Additional Annual Pollutant Load Removed	Additional Life-Cycle Pollutant Load Removed [a]
Total Phosphorus	84,659 lbs/yr	1,202,198 lbs
Fecal Coliform	2,166 Billion CFU/yr	30,759 Billion CFU
Total Suspended Solids	330,859 lbs/yr	4,698,358 lbs
Total Zinc	426 lbs/yr	6,055 lbs
Dissolved Zinc	0 lbs/yr	0 lbs
PCBs	6.7 grams/yr	94.5 grams

[a] 25-year life-cycle pollutant removal amount using a 2% discount rate, which matches the parameters used for the life-cycle cost analysis.

Exhibit 9-1: PCBs represent a de minimis fraction of constituents removed by NLT during the non-critical season
Source: City, 2014a

Based upon the City's evaluation in the Integrated Plan, whether to operate the NLT in the non-critical season is unrelated to PCBs.

> "*[O]perating the Membrane Filtration facility during the non-critical season results in the lowest life-cycle cost per unit of pollutant removed for all pollutants except fecal coliform, for which the CSO reduction projects have a slightly lower cost per unit.*" (City, 2014a, p. 4-15).

Additionally, the City admits that the effectiveness of the NLT in removing PCBs has not been scientifically established (City 30(b)(6), Coster, 2019, 30: 25; 31: 1-7).

None of the chemical dosing that Mr. Bowdan claims is required to operate the NLT during the non-critical season is designed to remove PCBs but is in fact required to ensure effective operation of the membrane modules. Mr. Bowdan claims costs for consumption of chemicals including coagulants (alum) and cleaning chemicals (sodium hypochlorite, sodium hydroxide, citric acid, sulfuric acid and sodium bisulfite) to operate the NLT during the non-critical season are related to PCBs. The City has admitted that alum (the coagulant) is required to ensure that the membranes operate properly (City 30(b)(6), Hendron, 2019, 256-257). This is further evidenced by observations during the Pall pilot study suggesting that alum alleviates membrane biofouling during the cold winter months (Esvelt, CH2MHill, and City of Spokane, 2016), unrelated to the presence of PCBs. Furthermore, Mr. Bowdan states that the cleaning chemicals are required to perform enhanced flux maintenance cleans. The City's pilot study using the Pall membrane established that the City would have to use these chemicals to ensure effective operation of the NLT during non-critical season for removal of other constituents, even if PCBs were never invented.

Mr. Bowdan claims utility costs (electricity, gas, and water) to operate the NLT during the non-critical season. As discussed above, due to the fact that the City chooses to operate NLT during the non-critical season to derive "net environmental benefit" via removal of several other constituents regardless of the presence of PCBs, none of the utility costs required to operate the NLT during the non-critical season can be attributed to PCBs.

Bowdan's claim that additional labor costs would be incurred due to the four additional months of operation is contradicted by Coster, the Plant Manager. Coster testified that the City needs highly trained and experienced personnel for NLT O&M (City 30(b)(6) Coster, 2019 67[44]). Based on this requirement for extensive training and experience, that these staff will be maintained throughout the year regardless of the operational status of the NLT system. Therefore, labor costs for the staff needed to operate the NLT are fixed whether the NLT is operating in the critical season or not.

Mr. Bowdan claims that 10 personnel (2 instrumentation repair technicians, 2 maintenance mechanics, 3 operators, 2 operations laborers and 1 chemist) will be required to operate the NLT. However, this contradicts the testimony of Michael Coster, Plant Manager, and the opinion of the NLT manufacturer (Pall Corporation) who have stated that only four new dedicated staffing positions will likely be required to operate the NLT during the critical season including one full time operator (three shifts per day) and one maintenance person (one shift) (City 30(b)(6), Coster, 2019, 60-61).

[44] A. You can't bring on -- the issue, one thing, you can't just suddenly, when NLT starts, you can't just suddenly hire people to operate it. You have to have long training and experience periods.

10. ADDITIONAL REBUTTAL OPINIONS

The following opinions respond directly to certain assertions expressed in the Trapp and Bowdan expert report (Trapp and Bowdan, 2019) which are not directly addressed in my opinions above but require rebuttal as they are inaccurate or misleading.

1. The current federally promulgated surface water criterion for PCBs is 170 ppq not 7 ppq (USEPA, 2019).
2. Trapp states that the estimated PCB loads from the City's MS4 (excluding CSO's) of 36.6 mg/day is 32% of the target instream load (Trapp and Bowdan, 2019, p. 25). Trapp calculates this target instream load based on an imagined 7 ppq surface water standard. Based on the 170 ppq actual surface water standard, Dilks' estimated PCB load from the City's MS4 is 1.3% of the target instream load.
3. All loading in Trapp's opinions is based on an assumed static concentration of PCBs in stormwater, which is not weighted for flow (Trapp and Bowdan, 2019, Table 4). Stormwater concentrations for all constituents vary significantly depending on when the sample is collected in the season, volume of flow, whether the sample is of the first flush or a flow weighted composite. The range of concentrations in Trapp's data set vary across nearly two orders of magnitude for Union basin underscoring the uncertainty of his loading analysis. Arithmetic mean calculations for concentration are further skewed by outlier data and are not representative of overall stormwater concentrations.
4. Bowdan states *"As the owner and operator of the CSOs and RPWRF, the City is required to mitigate its contribution of PCBs via the City-owned and -operated CSS and RPWRF to the river in order to achieve compliance."* (Trapp and Bowdan, 2019, p. 43)."

   Bowdan fails to identify any specific permit which requires the City to mitigate PCBs from the combined sewer system and RPWRF. There is no existing numeric discharge standard for PCBs in any City permit. The City requirements for CSO management are based only on number of overflows per year.
5. On Page 44 Bowdan states "*Due to the fact that PCBs are already present in the receiving water at levels exceeding the HHC, the City will be required to reduce or eliminate CSO PCB discharges from all of the City-owned and -operated CSO outfalls by reducing the discharge frequency from each controlled CSO outfall. This would primarily be accomplished by the City's current CSO reduction effort which minimizes overflows from each CSO outfall to not more than one per year based on a 20-year moving average period (Ecology 2011b).*"

   PCB levels in the Spokane river currently meet the 170 ppq surface water standard established for the State of Washington. Bowdan cannot predict future regulatory or permitting standards which have yet to be enacted. However, the City has been required to reduce or eliminate CSO discharges for decades, far before PCBs had been identified in

the river (Ecology, 1972). This requirement has nothing to do with PCBs, as admitted by the City (City 30(b)(6), Hendron, 2019, 86:88).

6. Bowdan states (p. 44) that the City is required to reduce PCB discharges from the RPWRF by constructing, maintaining, and operating the NLT. However, the City has admitted that the NLT facility was constructed for the sole purpose of meeting phosphorus discharge standards in the critical season, as required by its NPDES permit, and that no part of the NLT system was designed for PCB removal (City 30(b)(6), Hendron, 2019, 214; 264).

7. Bowdan's calculation of future overflow volumes (Trapp and Bowdan, 2019, Table 15) is based on an inappropriate methodology which invalidates his predicted future overflow volumes. Bowdan's method assumes that the average volume of overflows for each outfall prior to control from 2003-2012 will be equivalent to the volume of a single overflow in the future. For instance, CSO 26 had an average of 24 overflows per year, and discharged an average of 16.41 MG/year, so Bowdan concludes if there is only one discharge per year in the future that discharge will be 1/24th of the average total volume, or 0.648 MG. What he does not account for is that every storm is different in size, generating a different overflow volume. The CSO control measures the City is designing will attempt to capture all but the single largest storm each year. These storms are often significantly larger than any other storm of a given year. As shown in the graphed chart of overflows for CSO-26 in 2016 (Exhibit 10-1), if the system were designed to capture all but one overflow a year, the discharge volume would be over 7 million gallons. The overflow volume of the largest storm event each year has no correlation to the average overflow volume for an outfall. This underscores Mr. Bowdan's lack of understanding of the CSO system.

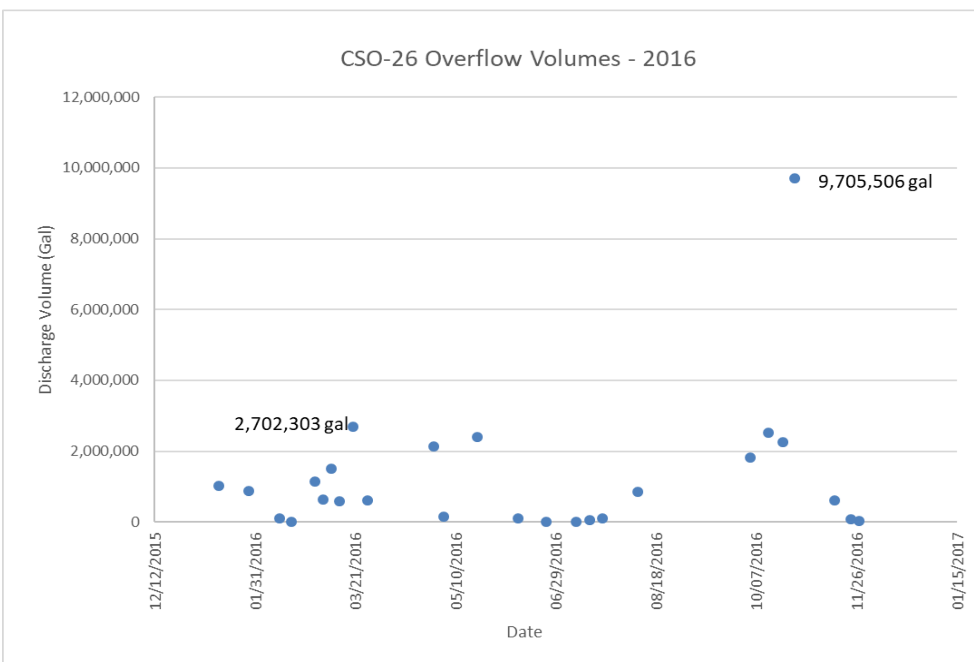

Exhibit 10-1: 2016 CSO discharge volumes
Source: City, 2016c

8. The City has not undertaken significant efforts to reduce or eliminate its use of goods known to contain by-product PCBs (Appendix C). Concentrations of these PCBs, which are unrelated to product PCBs, are detected in relatively high concentrations (PCB-11 at 521 ppq to 735 ppq) in City of Spokane sewer interceptors[45], and in the influent (up to 25,370 ppq) and effluent (25 ± 5 ppq) of the SCRWRF (Brown and Caldwell, 2016). The plaintiff's expert, Dr. Lisa Rodenburg, described these by-product PCBs as the main problem in the Spokane River 2017:

  "*And so this is a problem for the City of Spokane, or the County of Spokane, because they can go after the Aroclor-type sources. They're one of the cities suing Monsanto, for example. They can try to remove all transformers and capacitors. You know,* ***they can try to do lot of things to remove the Aroclor-type PCBs from their system. But that's not their main problem. Their main problem is PCB-11 for pigments****; and what are they going to do about that. That's quite difficult, because people are always going to use color-printed, you know, paper; and they're always going to wear printed clothing. And they're always going to have these pigments in their system. There's not much that Spokane County can do about their worst PCB problem.*" (Rodenburg, 2019b, 56-58; emphasis added).

  The Inland Empire Paper Company (IEP) is a known ongoing contributing source of by-product PCBs to the river (Northwest Green Chemistry, 2018). In addition, the City has and continues to knowingly contribute by-product PCBs to the river through the use of municipal goods containing by-product PCBs. In 2014, the City sampled 41 municipal products to determine if they contained inadvertently generated by-product PCBs because of their potential to be an ongoing source of PCBs to the Spokane River. Thirty-nine of these products contained by-product PCBs (City, 2015c). A majority of the tested products are applied in outdoor settings, such as road paint, pesticides, and de-icing materials, where weathering and stormwater runoff can transport by-product PCBs from these sources into the Spokane River.

  Efforts by the City to reduce its use of goods containing by-product PCBs have been at its convenience and required only when costs are minimal. In June 2014, it expanded its municipal code to include purchasing products and packaging free of all PCBs. Under Chapter 07.06, Section 07.06.172, *Preference for Products and Products in Packaging that Does Not Contain Polychlorinated Biphenyls*, the City departments may not knowingly purchase items containing by-product PCBs above the practical quantification limit except when it is not cost-effective or technically feasible to do so. The ordinance specifies that the criterion for determining if a purchase is not cost effective is if it increases the purchase price of the product by at least twenty-five percent. Moreover, departments are not required to test the products they procure.

[45] 2012 lab report from Pacific Rim Laboratories, report PR122547. Reference Spokane-PRR1578531.

Language reflecting this ordinance was included in only one request for bids, for a procurement of deicer material in 2015. No bids were submitted in response to the request. The City assumed the lack of response was due to the requirement for evaluation of by-product PCB content and removed this requirement from future bid requests (Northwest Green Chemistry, 2019). Thus, the City failed in all but one instance to require that bidders reduce the use of goods containing by-product PCBs. And when that request was included but yielded no bidders, the City quietly abandoned the language. The City continues to use and release by-product PCBs to the river, which are the “main problem” according to the plaintiff’s expert (Rodenburg, 2019b).

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APPENDIX A

Michael C. Kavanaugh, Ph.D., P.E., BCEE – Resume

Geosyntec consultants

MICHAEL C. KAVANAUGH
Senior Principal

Water treatment process engineering
water quality management and water reuse
RI/FS/site remediation
environmental audits and due diligence
engineering design
industrial and municipal wastewater treatment
waste minimization/pollution prevention
peer review/strategic consulting
alternative dispute resolution
litigation support/expert witness

EDUCATION

Ph.D., Civil/Sanitary Engineering, University of California, Berkeley, CA, 1974
M.S., Chemical Engineering, University of California, Berkeley, CA, 1964
B.S., Chemical Engineering, (*Cum Laude*), Stanford University, Stanford, CA, 1962

PROFESSIONAL REGISTRATIONS

Registered Profession Engineer (Chemical), California (1980 – present)
Board Certified Environmental Engineer, American Academy of Environmental Engineers and Scientists (1986 – present)
Security Clearance**,** Q-Clearance Status, (1991-1993)

CAREER SUMMARY

Dr. Kavanaugh is a chemical and environmental engineer with more than 40 years of professional experience, providing a broad range of environmental and chemical engineering and consulting services to private and public sector clients. His areas of expertise include water quality management, water treatment, potable and non-potable water reuse, municipal and industrial wastewater treatment, hazardous waste management, site remediation with particular focus on groundwater remediation, cost allocation between potentially responsible parties at contaminated sites, fate and transport of contaminants in the environment including impacts to surface waters, and technology evaluations including patent reviews of environmental technologies. He has extensive experience with water treatment projects involving treatment of severely impaired groundwater resources and other industrial waste streams. Dr. Kavanaugh was the principal editor and author of several chapters in the textbook, "Water Treatment: Principles and Design", published by Wiley in 1986. The textbook was used in numerous graduate level programs and is now in a third edition. Dr. Kavanaugh currently provides

instruction on water and wastewater treatment technologies through the Princeton Hydrology and Remediation commercial courses offered to practicing professionals.

Dr. Kavanaugh has extensive litigation experience, both as a testifying expert and a fact witness on engineering and hydrogeologic issues related to hazardous waste sites as well as on other issues related to his areas of expertise. He also has participated on several mediation and arbitration panels as a neutral technical expert as well as serving as an individual facilitator, mediator, arbitrator, or court appointed expert.

Dr. Kavanaugh has been project engineer, project manager, principal-in-charge, technical director or technical reviewer on over 230 projects covering a broad range of environmental issues. He has authored or co-authored over 35 peer reviewed technical publications, edited and contributed to five books, and has made over 170 presentations to technical audiences as well as public groups including testimony before congressional and California state legislative committees. Dr. Kavanaugh is a registered professional chemical engineer in California, and a Board-Certified Environmental Engineer, under the auspices of the American Academy of Environmental Engineers and Scientists (AAEES), with certification in water and wastewater engineering, hazardous waste management, site remediation and sustainability. Dr. Kavanaugh was elected into the National Academy of Engineering in 1998. In 2013, he was elected as a fellow of the Water Environment Federation. Since 1999 to the present, Dr. Kavanaugh has been a Consulting Professor, in the Civil and Environmental Engineering Department of Stanford University.

Water Quality Management, Water Treatment and Water Reuse

Operation and Evaluation, Advanced Water Treatment Plant, *Washington, D.C.* Project Manager for operation and evaluation of 1 MGD advanced water treatment plant to test the use of the contaminated Potomac River as a potable drinking water source under area specific drought conditions. Water quality issues included estimating water quality levels under drought conditions in the Potomac River estuary, and evaluation of water quality standards for potable reuse beyond those required by the Safe Drinking Water Act of 1974 and subsequent amendments. The testing program included evaluation of the efficiency of advanced water treatment processes, including activated carbon, membrane filtration, and reverse osmosis, for removing or reducing the levels of more than 220 chemical, microbial and physical constituents found in wastewater. The project included extensive toxicological and microbiological tests on treated water from the pilot plant and comparison with the water quality produced at three local water treatment plants. The project generated over 400,000 data points. The Final Report was submitted to peer review by the National Academy of Sciences and transmitted to the U.S. Congress asserting that it was technically feasible to produce water of drinking water quality under the conditions simulated.

Charnock Water Treatment Project*, Santa Maria, California.* Project Manager for the Charnock Water Treatment project to design a new drinking water treatment plant for the City of Santa Monica, CA. Treatment plant (10 mgd capacity) was designed to remove MTBE and TBA to non-detect levels. Treatment plant constructed in 2011.

Fate of Methanol in Columbia River, Northwest Innovation Works, Inc., *Kalama, WA****.*** Dr. Kavanaugh was the co-project director on a study of the fate of methanol following a hypothetical spill during tanker transport. Geosyntec was retained by the company to respond to issues raised in public responses to the draft Environmental Impact Report (EIR) prepared for permit application to construct a methanol refinery at the Port of Kalama on the Columbia River. The project including definition of a reasonable worst-case spill scenario, surface water model development and scenario assessment, and incorporation of appropriate fate and transport mechanisms in the model code. Dr. Kavanaugh presented the results of the study to the hearing officer in a formal public hearing in 2017.

Treatment and Removal of n-nitrosodiethylamine, Water Reuse Foundation*, Nationwide.* Principal Investigator for the Water Reuse Foundation directing a study on the formation, fate and transport, and treatment for removal of n-nitrosodiethylamine (NDMA) in chlorinated municipal wastewater effluent. Participating utilities included several Bay Area dischargers, West Basin Water District, and the City of Scottsdale.

Cyanide Levels, Sacramento Regional County Sanitation District Wastewater Treatment Plant, *Sacramento, California*. Project Director for a study on control of total cyanide levels in effluent from the Sacramento Regional County Sanitation District Wastewater Treatment Plant.

Title 22 Design Criteria for Wastewater Filtration*, Nationwide.* Chair of Project Advisory Committee for a National Water Research Institute-funded project evaluating Title 22 Design Criteria for wastewater filtration and laboratory and pilot studies to assess impacts of increasing filtration rate above current requirement of 5 gallons per minute/square foot.

Dioxin Total Daily Maximum Loads (TMDLs), Regional Petroleum Refineries, *San Francisco Bay Area, California****.*** Project Manager for an evaluation of appropriate statistical models to develop TDMLs for dioxin-equivalents in wastewater discharges from petroleum refineries in the San Francisco Bay Area.

Cyanide Studies, Water Environment Research Foundation*, Nationwide*. Principal-in-Charge for direction of a three-year project on cyanide species in municipal wastewaters under contract to the Water Environment Research Foundation (WERF). Project involved assessment of alternative analytical techniques to measure cyanide species, modeling of cyanide fate and

transport in wastewater treatment systems, and evaluation of alternative management strategies to maintain compliance with total cyanide discharge standards between 5 and 50 ppb.

Ferrocyanide Evaluation, *Confidential Client*. Project Manager for the evaluation of fate and transport of ferrocyanide in surface waters, groundwater, and sanitary sewers.

Cyanide Effluent Evaluations, City of Sunnyvale, and East Bay Municipal Utilities District, *Sunnyvale and Oakland, California*. Project Manager for the investigation of causes and control options for total cyanide in wastewater effluent from City of Sunnyvale, CA wastewater treatment plant, and East Bay Municipal Utilities District (EBMUD) wastewater plant.

Water Quality Expert Witness, Delta Wetlands Properties, *Northern California*. Expert witness on water quality issues, with respect to the impact of proposed Delta Islands Water Storage Project on Delta export water quality. Major concern was the potential leaching of organic matter from submerged islands in the Delta. Prepared expert testimony as part of water rights permit hearings before the State Water Resources Control Board, California. Issues included estimate of dissolved organic carbon (DOC) releases from reservoir sediments under a flooding scenario and possible increase in this water quality parameter in export water from the Delta.

Water Treatment Plant Evaluation, City of Cordoba, *Argentina*. Dr. Kavanaugh was retained by the World Bank to evaluate options for control of disinfection byproducts in the treated water produced by the City's main water treatment plant. The water supply source was a lake subject to eutrophication during summer months, leading to elevated levels of dissolved organic carbon and thus increase levels of disinfection byproducts that exceeded relevant drinking water standards. The project lead to modifications to the coagulation process to increase organic carbon removal.

Water Quality 2000, *Switzerland*. Project Manager for a study that involved projections of population density, industrial production, unit waste production, and evaluation of transformations of chemicals in receiving waters. Report provided basis for long-term strategy to protect water quality in Swiss surface waters.

Testifying Expert, Government of Argentina, *South America*. Testifying expert for the Government of Argentina in a dispute involving water resources management and treatment in South America. Prepared an expert report. The engagement ended after hearing at the International Centre for Settlement of Investment Disputes.

Industrial and Municipal Water and Wastewater Treatment

Valdez Refinery, Exxon, *Valdez, Alaska. P*rovided technical review of engineering options for treatment of ballast water at the Valdez refinery, Alaska. Ballast water treatment plant upgrade was required to meet new NPDES requirements for BTEX. Participated in design of an innovative enhanced biological treatment system with post treatment using an air stripping system installed within existing structure.

Vallejo Wastewater Treatment Plant, *Vallejo, California*. Project Manager for lab scale and pilot testing of physical-chemical methods for removing metals and organics from wastewater at the Vallejo Wastewater Treatment Plant. This POTW treats a high fraction of industrial wastewater.

Evaluation, Aluminum Anodizing Plant, *Arizona.* Principal-in-Charge of an industrial wastewater treatment evaluation for an aluminum anodizing facility. Waste streams characterized by both low and high pH, and high metals content.

Niagara Falls Wastewater Treatment Plant, *Niagara Falls, New York*. Part of a team of experts that evaluated wastewater treatment options for removal of toxins in the Niagara Falls Wastewater Treatment Plant, New York. Previous treatment facility was predominantly a physical-chemical plant. High level of biodegradable organic matter rendered the GAC system dangerous due to production of hydrogen sulfide.

Eastman Chemical Company, *Tennessee*. Technical review of proposed industrial waste treatment facilities to be installed by Eastman Chemical Company to meet Clean Water Act requirements for control of toxic organics and suspended solids.

NUMMI Auto, *Fremont, California.* Principal-in-Charge of a project to improve performance of industrial waste treatment plant that treated paint wastes from spray booths at a major auto manufacturing plant in Fremont, California.

Contra Costa County Water Treatment Plant, *Walnut Creek, CA.* Project engineer in support of project to reduce the production of disinfection by-products through enhancement of removal of natural organic matter during coagulation/sedimentation process. Conducted lab scale studies to optimize dose and mixing requirements to reduce organic matter that serves as precursor for the disinfection by-product formation during chlorination for disinfection.

Engineering Design

***Pump and Treat System Review, Castle Air Force Base**, California*. Provided technical review of process design and specifications for a pump and treat system at Castle Air Force Base, California. System included extraction wells, filtration for particulate removal, air stripping with low profile air strippers, and GAC vapor treatment.

***SVE System Evaluation, David Monthan Air Force Base**, Arizona.* Provided technical review and analysis of plans and specifications for a soil vapor extraction system at the Davis Monthan Air Force Base, Arizona.

***Remediation System Evaluation, Los Angeles Department of Water and Power**, Los Angeles, California.* Provided technical review of plans and specifications for a 2,000 gpm air stripper, with vapor phase GAC system, installed by the Los Angeles Department of Water and Power to treat groundwater. Also evaluated the use of UV/Ozone for off-gas treatment.

***Process Engineering Review, Stringfellow Superfund Site and BKK Landfill,** Southern California*. Provided process engineering and review of plans for leachate treatment systems to remove VOCs, nonvolatile organic chemicals, and metals at the both the Stringfellow Superfund site and the BKK landfill.

Alternative Dispute Resolution (Mediation, Arbitration, Facilitation)

***Facilitation of Technical Issues, BNSF Sites,** Montana*. From 2010 to the present, Dr. Kavanaugh has served as an independent facilitator in meetings between consultants and regulators addressing a range of technical issues that have arisen at six BNSF sites in the state of Montana regulated under the Montana State Superfund Program. The overall goal of this facilitation process was to accelerate the decision processes for more timely initiation of appropriate remedial actions at each of the sites. Issues include; a) definition of background concentrations for arsenic and other metals, b) effectiveness of LNAPL recovery technologies, c) appropriate characterization of vapor intrusion (VI) risks at operating rail yard facilities, d) strategies for addressing DNAPL in bedrock environments, and e) suitability and validity of fate and transport models of various organic contaminants including pentachlorophenol and chlorinated solvents at selected BNSF sites in Montana. Dr. Kavanaugh continues (2019) to provide strategic advice to BNSF project managers on several large complex sites in the BNSF portfolio of sites in the western US.

***Resolution of Dispute on Residual Oil Contamination in Kalamazoo River,** Michigan*. Dr. Kavanaugh was retained by Enbridge Corporation to facilitate a resolution of a technical dispute between Enbridge and the Environmental Protection Agency (EPA) on the quantity of

residual oil remaining in the Kalamazoo River following a 2010 pipeline release of highly viscous petroleum and after three years of mitigation measures. Using an appropriate statistical methodology, Geosyntec's team, directed by Dr. Kavanaugh, determined that the residual estimate was either inflated or underestimated based on the methods used to quantify the impact of non-detect values for biomarkers specific to the petroleum released. The Geosyntec approach resulted in a defensible estimate of the residual oil in the river as distinguished from background hydrocarbons.

Remediation of Chlorinated Solvent Plumes, Edwards Air Force Base, *California.* Served as facilitator of stakeholder group addressing remediation of chlorinated solvent plumes (primarily TCE) at Edwards AFB, California. Stakeholders included representatives from Air Force, USEPA, Region 9, California Regional Water Quality Control Board, and California Department of Toxic Substances Control (DTSC). Used a modified Nominal Group Technique to achieve consensus on priority issues to be addressed in focused feasibility studies for decisions on final remedial strategies for groundwater cleanup.

Cost Allocation, Kai Tak Airport, *Hong Kong, Japan.* Selected to mediate a dispute between the Government of Hong Kong and seven international oil companies regarding cost allocation between the parties to remediate portions of the Kai Tak airport in Hong Kong following closure of the airport. Contaminants were primarily petroleum-based compounds (BETX, TPH). A settlement agreement was accepted by all parties.

Oil Contamination, Cost Allocation. Served as an arbitrator to resolve a dispute between two oil companies over costs for cleanup of soil and groundwater contaminated with petroleum hydrocarbons including the fuel oxygenate MTBE at two gas stations previously owned by one of the oil companies.

Gould Superfund Site, *Portland, Oregon****.*** Member of a mediation panel established by JAMS to resolve a cost allocation dispute at the Gould Superfund site near Portland, Oregon. Issues included cost allocation between PRPs, resolution of sources/contributions of PAHs/dioxins to soil and groundwater, and consideration of Gore factors for equitable allocation between the parties. Also served as an independent expert preparing an arbitration decision on dispute between responsible parties at the Gould site, on cost liabilities for failed remedy and cost liabilities for subsequent remedial costs.

Cost Allocation for Cleanup, San Francisco International Airport, *San Francisco, California****.*** Member of two-person panel working with JAMS to resolve a cost allocation dispute between the City of San Francisco and several oil companies regarding costs for soil and groundwater cleanup at the San Francisco International Airport.

Risk Management, UXO, US Army Corps of Engineers, *California*. ***S***erved as a facilitator in meetings organized by the U.S. Army Corps of Engineers to address risk management issues associated with possible remediation of former military bases where unexploded ordinance (UXO) could be present. Involved parties included representatives from the California DTSC, Army Corps, and UXO remediation experts.

McNally Canal Operation, *Inyo County, California*. Member of three-person arbitration panel established to arbitrate a dispute between Inyo County, CA, and the Los Angeles Department of Water and Power on the operation of the McNally Canal in California.

Dispute Mediation, Los Angeles Unified School District, *Los Angeles, California*. Member of a three-person panel that mediated a dispute between the Los Angeles Unified School District and a law firm in Los Angeles. Technical issues including potential or actual risks from methane and hydrogen sulfide gases emanating from oil fields beneath a new high school in downtown Los Angeles.

Mediation Panel, *Northern California***.** Member of a two-person mediation panel to settle a dispute between a golf course developer, State Water Resources Control Board, Regional Water Resources Control Board, the affected city, and citizen stakeholder groups. Met with each group to facilitate resolution of dispute through structured facilitation process.

Assessment of Damages from Fungicide Manufacturing, Central Valley, California. Member of three-person mediation team organized by JAMS to settle dispute over damage claims between the City of Fresno, CA, and three chemical companies who manufactured fungicides (DBCP and EDB) used on crops in the Central Valley, CA. Case settled based on technical approach proposed by mediation team.

ACME Landfill Closure, *Pittsburg, California***.** Directed technical evaluation of alternative closure plans for the ACME Landfill as basis for mediation settlement of cost allocation issues between owner/operator and waste generators.

Water Rights, *Livermore, and Dublin, California*. Mediator to settle dispute between City of Livermore, CA and Dublin/San Ramon Sanitation District over water rights issues.

FMC Corporation, *Fresno, California*. Technical Advisor for FMC Corporation during mediation process to settle dispute over cost allocation for commingled TCE and hexavalent chromium plumes at a site in Fresno, CA.

PCE Contamination, *Lodi, California***.** Court designated expert to advise Federal Judge F. Damrell on technical issues related to a dispute between the City of Lodi, CA, and potentially

responsible parties regarding PCE contamination originating from several sources including dry cleaners.

Litigation Support / Expert Witness in Previous Four Years

Assessment of Residual Impacts and Remedial Alternatives, Alcoa Corporation, *Vernon, California.* Dr. Kavanaugh was retained on behalf of Alcoa as an expert witness to present his opinions on the appropriateness and consistency with the NCP of remedial measures at a former manufacturing facility in Vernon, CA. He reviewed existing data and assessed impacts of residual chlorinated solvents and Stoddard solvents in soil. The Site is under the jurisdiction of the California Department of Toxic Substances Control (DTSC). He reviewed and reported on several remedial measures that had been implemented at Site including concrete removal, excavation, soil vapor extraction, and sub-slab venting systems installed beneath newly constructed buildings. Dr. Kavanaugh prepared an expert report, rebuttal reports, response to rebuttal reports and was deposed as part of litigation proceedings regarding the dispute with the current site owner. Trial expected 2020.

Cost Allocation Dispute: North Pole Petroleum Refinery, *North Pole, Alaska.* Dr. Kavanaugh served as an allocation expert in a dispute between the former and current owners of a petroleum refinery in North Pole, Alaska. On behalf of the current owner, Dr. Kavanaugh, relying in part on the results of a comprehensive groundwater fate and transport model, provided opinions on the equitable allocation of past and future costs incurred due to the off-property migration of the solvent sulfolane, a chemical used to extract aromatic hydrocarbons from petroleum fractions. The allocation methodology followed the appropriate application of the Gore Factors, widely used in allocation disputes at contaminated sites. Dr. Kavanaugh provided deposition testimony in the matter and was prepared to offer rebuttal opinions at the trial phase of the dispute. Trial was completed in October 2019 and ruling is in progress.

MTBE Litigation on Groundwater Contamination, *Orange County, CA.* On behalf of several of the oil company defendants in the MTBE litigation in Orange County, CA in opposition to the Orange County Water District (plaintiffs), Dr. Kavanaugh provided expert testimony on appropriate and cost-effective remediation strategies at four petroleum distribution sites impacted by gasoline releases and selected for evaluation by the disputing parties. Plaintiffs experts provided highly inflated cost estimates for remediation. Issues in dispute included appropriate remediation strategies to address MTBE and TBA in groundwater and future costs required to meet applicable cleanup standards in soil and groundwater. Case settled (2019) following deposition testimony.

MTBE Multidistrict Litigation on Groundwater Contamination, *New Jersey*. On behalf of one of the oil company defendants in the MTBE litigation in New Jersey, Dr. Kavanaugh provided expert testimony on appropriate and cost-effective remediation strategies at the ten sites selected

for evaluation by the disputing parties. Fuel oxygenates (MTBE and possibly TBA) were released at the sites. Issues in dispute included whether sites had been sufficiently characterized, what receptors were at risk, selection and design of appropriate remedial systems, and justification for remedial goals. Case settled (2017) following deposition testimony.

City of Hattiesburg versus Hercules Litigation, Hattiesburg, MI. Dr. Kavanaugh was retained by Hercules Corporation to testify on issues arising from claims of the City of Hattiesburg that contaminants found at the nearby Hercules chemical facility had impacted the water supply source for the City. No evidence was found that supported a completed exposure pathway between the Hercules facility, where a RCRA Corrective Action Plan had been implemented, and the deeper aquifer which was the source of water for the City. Contaminants of concern included benzene, carbon tetrachloride, chlorobenzene, chloroform, ethylbenzene, toluene, total xylenes, 1,4-dioxane, 1,1-biphenyl, and diphenyl ether. Dr. Kavanaugh prepared an expert report and was deposed in 2017. Case settled before trial

Vapor Intrusion Exposure Litigation, *California.* Dr. Kavanaugh was retained by a confidential industrial company to opine on fate of chlorinated solvents in groundwater beneath their property more than 30 years ago. Plaintiff parties alleged that workers in a building were recently exposed to organic chemicals used by company in the past. Among various issues, Dr. Kavanaugh opined on whether the groundwater was a potential source of the chemicals considered to be the cause of alleged vapor exposure. Case settled in 2015 without a trial.

Perchlorate/TCE Litigation, *Rialto, California*. On behalf of Goodrich Corporation (now UTC), Dr. Kavanaugh served as an expert on the sources, fate and transport of TCE and perchlorate, alleged to have been released during Goodrich operations in the late 1950s to early 1960s on a site in the Rialto-Colton Groundwater Basin. The area is now known as the Rockets, Flares and Fire Superfund Site. Dr. Kavanaugh prepared several declarations on a range of issues in dispute including the most likely sources of the contaminants of concern, whether commingling of plumes occurred down gradient of the source areas, and whether the contribution of contaminants from known source areas could be ascertained based on limited temporal signals in the groundwater. Dr. Kavanaugh has also served as an expert on an insurance coverage dispute at this Site on behalf of Goodrich Corporation as plaintiff in the matter. The dispute settled without a trial following depositions of experts in 2015.

Kaust Tank Farm Carousel Housing Tract Litigation, *Carson, California*. Dr. Kavanaugh was retained by a confidential client to provide expert testimony for one of the defendants in the matter on fate and transport of petroleum hydrocarbons, released from a former Tank Farm and impacting soil and groundwater beneath a large housing tract. Dr. Kavanaugh was asked to develop opinions on the proposed remedial strategies being considered by the responsible

parties to address risk concerns arising from residual petroleum hydrocarbons present in soil and groundwater beneath the homes in the housing tract. Case settled prior to deposition testimony in 2015.

Stringfellow Acid Pits Superfund Site, *Riverside County, California.* Testifying expert for the State of California (plaintiff) in a dispute with insurance companies over recovery of past and future costs associated with the remediation of the Stringfellow Acid Pits Superfund Site in Riverside County, California. Prepared expert report on past and future costs, consistency of past remedial actions with the National Contingency Plan (NCP), appropriateness and reasonableness of past and future remedial actions. Testified at a jury trial in 2005. Case continued with several insurance companies who appealed the decision. Dr. Kavanaugh completed a revised expert report and was deposed again in 2015. Case settled before another trial.

RI/FS and Site Remediation

Remedial Investigation/Feasibility Study, Troy Superfund Site, *Newark, NJ***.,** Dr. Kavanaugh is serving as a technical advisor and quality assurance reviewer of an on-going (2019) Superfund Site at the Troy Chemical property in Newark, New Jersey. This is an operating chemical facility producing several proprietary chemicals used in various industrial applications. Soil and groundwater contamination exist, caused primarily by disposal practices of previous owners and impacts from off-site activities during the past 100 years of industrial activity. The Site was listed on the NPL in 2015 and the RI/FS is in progress (2019).

General Mills Corporation, Minneapolis: Site Delisting. Dr. Kavanaugh, and Geosyntec staff have been providing consulting expert advice through a law firm to General Mills Corporation who desires delisting of a former facility used to conduct food research in the 1960s from the Minnesota State Superfund List and the EPA National Priorities List (NPL). GM completed a pump & treat remedy for TCE removal at their former site in 2010 after more than 25 years of remediation. Subsequent investigations of a vapor intrusion impact from the TCE plume revealed numerous upgradient sources of TCE impacting the property. An area upgradient of the former site is now a newly designated Superfund site. Continued discussions with EPA and the State Agency (Minnesota Pollution Control Agency, MPCA) are addressing various issues in dispute including; 1) magnitude of TCE source attributable to GM activities, 2) adequacy of 25 years of P&T to address TCE and other chemicals of concern, 3) whether site continues to contribute TCE environment due to continuing vapor intrusion threats. Matter still under review.

Remedial Investigations, Four NPL Sites, *San Fernando Valley, California.* Project Manager and Principal-in-Charge on a major remedial investigation (RI) of four NPL sites in the San Fernando Valley of Southern California. The project included extensive soil gas testing to locate multi-piezometer monitoring wells, preparation of a three-dimensional groundwater flow model, and the definition of the nature and extent of contamination in the groundwater at the four NPL sites. RI showed that several million pounds of trichloroethene (TCE) and tetrachloroethene (PCE) render the aquifer unusable without treatment.

U.S. Navy Moffett Field, *Mountain View, California*. Provided technical review and oversight on soil and groundwater investigations of groundwater contamination at U.S. Navy Moffett Field, California. Key technical issues included allocation of financial responsibility for remediation of TCE plume caused by releases from U.S. Navy facility and releases from upgradient industrial sources.

Former Steel Mill, Chino Basin, *California.* Project Manager for investigation of groundwater contamination at a former steel mill in Southern California located above a sole-source aquifer (Chino Basin). Studies showed extensive degradation from TDS discharges and major non-toxic organic plume that could impact municipal wells used to extract groundwater for potable use. Evaluated reuse of extracted water by local industries.

Remedial Investigation, Oil Refinery, *New Orleans, Louisiana.* Provided technical oversight for a large RI of a former oil refinery near New Orleans. The site was directly in the path of a new freeway. Extensive testing and analysis of soil and groundwater were required. Innovative on-site analytic protocols were developed to accelerate the site investigation.

Site Investigations, U.S. Chemical Plants, *Netherlands and Belgium*. Principal-in-Charge for site investigations carried out at two operating chemical facilities owned by a major U.S. Chemical Company in the Netherlands and Belgium. Both sites had soil and groundwater contamination including the presence of dense non-aqueous phase liquids (DNAPLs). Project included RI/FS and human health risk assessment. Soils contaminated with molybdenum and synthetic organic chemicals.

Expert Panel Member, Site Exist Strategies, Confidential Client, *Australia.* Member of an expert panel convened by a private company in Australia to hold a workshop to discuss potential site exit strategies. Work performed involved review of site documents, assessment of the conceptual site model and past performance of remedial actions, and recommendations for a path forward. Gave a presentation to the workshop attendees summarizing assessments and recommendations.

Williams Air Force Base, U.S. Air Force*, Arizona.* Technical advisor to the U.S. Air Force on implementation of a thermal remedial technology for remediation of jet fuel and other petroleum hydrocarbons at Williams Air Force Base, Arizona. Final decision on use of thermal technology (Thermally Enhanced Extraction) pending (2010).

Cost Allocation Evaluation, Emerson Electric Company, *Florida*. Technical support to Emerson Electric Company at a multi-party PRP site in Florida. Key issues included cost allocation based on treatment costs for specific compounds and value engineering of the remedial action plan at the former chemical recycling facility.

Closure Strategies, Anniston Army Depot, *Anniston, Alabama*. Technical Advisor to Army Environmental Center (AEC) regarding closure strategies at Anniston Army Depot, Anniston, AL. Technical scope included review of feasibility studies, assessment of technical feasibility of source removal, and analysis of technical impracticability for an ARAR waiver report.

Remedial Action, Pipe Manufacturing Facility*, Napa, California*. Project Manager and Principal-in-Charge for remedial actions at a pipe manufacturing facility in Napa, California. Soil and groundwater were contaminated with total petroleum hydrocarbons, solvents, and metal wastes. Remedial actions have included on-site bioremediation for total petroleum hydrocarbon (TPH) reduction, on-site stabilization, and solidification of metal wastes, permitting for on-site storage of wastes, and pump and treat for control of a volatile organic compound (VOC) plume.

China Lake Naval Weapons Center, *China Lake, California.* Project Manager for remedial actions to recover JP-4 jet fuel found beneath former fire-fighting facility at the China Lake Naval Weapons Center, California. A dual pump recovery system with air stripping of the extracted water was installed.

Crazy Horse Landfill, *Salinas, California*. Project Manager for site investigation, feasibility study, remedial action plan development, and implementation of remedial actions for control of contaminated groundwater at the Crazy Horse Landfill, a NPL site in Salinas, California. Remediation system included an innovative passive air stripping system for removal of VOCs with off gas treatment by granular activated carbon (GAC).

Remedial Action Program, Industrial Facility*, Florida.* Project Manager overseeing a pump-and-treat remedial action program at an industrial facility in southwest Florida. Ground water contamination caused by release of 1,1,1-trichloroethane (1,1,1-TCA) and abiotic degradation product of 1,1-dichloroethene (1,1 DCE). Project included negotiations with the Florida Department of Environmental Protection (FDEP). A four-year extraction program to demonstrate compliance with clean up levels (MCLs) at the property boundary was successful.

Chemical Facility, *Santa Fe Springs, California.* Project Manager and Principal-in-Charge for the RI/FS/ and remedial design at a former chemical facility in Santa Fe Springs, California. Obtained approval for a remedial action plan by the lead regulatory agency that includes capping of the site, and hydraulic containment of impacted groundwater using a pump and treat system. Oversaw optimization of remedial system and assessment of natural attenuation processes at the site.

Review of Remediation Technologies, Hill Air Force Base*, Utah.* Provided technical review for innovative technologies being tested at Hill Air Force Base in Utah. Technologies evaluated include surfactant flushing and co-solvent flushing for removal of DNAPLs, the use of chlorinated “funnel and gate" technology with iron filing reactors for reductive dehalogenation of solvents, bioventing, and in situ bioremediation of chlorinated solvents.

Technical Review, CERLA Site, ARCO*, Montana*. Provided review of a technical impracticability (TI) report prepared for USEPA at a Superfund site in Montana.

Penn Mine, East Bay Municipal Utilities District*, C*alifornia. Project Manager responsible for feasibility analysis of alternatives to manage acid mine drainage from Penn Mine, an abandoned copper mine located on property owned by East Bay Municipal Utilities District.

J.H. Baxter Superfund Site*, Weed, California*. Project Director responsible for analysis of technical feasibility of USEPA-mandated remedy at the J.H. Baxter Superfund site in Weed, CA. Key issues involved assessment of technical feasibility of groundwater restoration in the presence of creosote DNAPL below the water table, and strong adsorption of arsenic to specific soils. Based on analysis, USEPA agreed to assess alternative strategies for the site.

Site Remediation Consulting, Confidential Client*, US and Europe*. Technical Advisor for a major U.S. Chemical Company on site remediation issues at U.S. and European facilities.

Review of Remediation System, Semi-conductor Facility, Confidential Client*, Long Island, New York*. Principal-in-Charge responsible for review of pump-and-treat system at a semi-conductor manufacturing facility on Long Island, NY. Contaminants included TCE, PCE, and 1,1,1-TCA. Assisted client in negotiating an agreement to cease operation of the remediation system.

Audits/Due Diligence

Confidential Airline Company. Principal-in-Charge for a due diligence evaluation for major airline company considering purchase of a fueling company in the U.S.

Fortune 200 U.S. Electronics Company. Principal-in-Charge for a due diligence study for a Fortune 200 U.S. electronics company as part of the purchase of a manufacturing facility in the United Kingdom. Project involved soil and groundwater sampling, risk assessment, and analysis of costs for potential remedial measures. Provided strategic support to the client in successful negotiation of the property purchase despite finding contamination in soil and groundwater.

Former Pipe Manufacturing Facility, *Northern California*. Project Manager for due diligence evaluation of soil and groundwater contamination at a former pipe manufacturing facility in Northern California. Investigations uncovered several potential problems at the site. Remediation scenarios and cost estimates were developed to provide a basis for sale of company.

Manufacturing Facility, *Santa Clara County, California*. Project Manager for an environmental audit of a Silicon Valley manufacturing facility that was foreclosed by a California bank. The site was found to be contaminated with volatile organic chemicals and metals caused by a leaking sewer system and from spills within buildings. Estimated environmental liabilities exceeded value of loan on the property.

HB Fuller Company, *Germany and Austria*. Principal-in-Charge for site audits at three operating facilities owned by HB Fuller Company in Germany and Austria. Activities included soil and groundwater sampling and preparation of summary reports.

Preliminary Assessments/Site Inspections, Former Steel Mill, *Southern California.* Principal-in-Charge for preliminary assessment/site inspection to assess potential contamination at former steel mill in Southern California. Site encompasses 1,000 acres and included 28 waste management units with potential soil contamination. The sites were prioritized, and a program implemented for a RCRA Facility Investigation (RFI) and Corrective Measures Study (CMS).

Due Diligence, Auto Shredding Facility, *Southern California.* Project Manager for due diligence audit of an auto shredding facility in Southern California. Sampling included soil, auto shredding waste, and groundwater to determine extent of soil and groundwater contamination, and to evaluate disposal options for shredder waste.

Engineering Feasibility Evaluations

Hazardous Waste Generation Analysis, SITA, *France.* Project Manager for an assessment of hazardous waste treatment technologies for handling contaminated soils under contract to SITA, a French waste management company. Project involved estimating quantities of hazardous wastes generated in France and other European countries and an assessment of applicable

stabilization/solidification technologies. Information was used by SITA to license appropriate technologies for stabilization/solidification facilities in France.

Potable Re-use Plant Evaluation. Program Manager and Technical Director for investigation of alternative technologies to control synthetic organic chemicals in a potable reuse plant. Technologies evaluated included GAC, air stripping in packed towers, ion exchange, electrodialysis, low pressure reverse osmosis membranes, and UV/ Ozone oxidation.

State-wide Assessment, VOC Removal from Utilities, *New Jersey*. Project Manager for a state-wide assessment of VOC removal options for utilities in the state of New Jersey. Prepared a report, which was widely distributed, assessing the magnitude of the VOC removal problem in New Jersey, and estimating costs for compliance of new facilities.

Technical Reviewer, Great Lakes Water Quality, Ministry of the Environment, *Toronto, Canada*. Technical review for an advanced water treatment project for control of synthetic organic chemicals found in the Great Lakes. Assessed impact to water treatment plants in Canada.

Stringfellow Hazardous Waste Site, *Riverside County, California*. Provided an evaluation of technologies proposed for remediation for portions of the Stringfellow hazardous waste site. Assessed suitability of soil vapor extraction and other technologies for removing volatiles from major waste zones at the site.

Groundwater Remediation Consulting, Confidential Tire Manufacturer. Provided technical support to major U.S. tire manufacturer on strategies for groundwater remediation. Technologies reviewed included pump and treat, in situ bioremediation, in well aeration systems, funnel and gate technologies, air sparging, and bioventing.

Waste Minimization/Pollution Prevention

United States Air Force, *Germany, United Kingdom, Italy, and Turkey*. Principal-in-Charge for a study evaluating waste minimization options at six operating U.S. Air Force Bases in Germany, UK, Italy, and Turkey. Project involved development of a database structure for audits of hazardous materials used and wastes generated at the facilities. Alternatives for reducing wastes were evaluated and recommendations made to meet the Air Force goals of 25% reduction in hazardous waste generation.

Fabric Manufacturing Plant, *United Kingdom*. Provided technical review for an assessment of water minimization options at a fabric manufacturing facility.

Copper and Nickel Discharge Reductions, Santa Clara County Manufacturing Association, *Santa Clara County, California*. Principal-in-Charge for technical consulting to the Santa Clara County Manufacturing Association for assessment of options to reduce copper and nickel discharges from local industries. Waste minimization options as well as end-of-pipe treatment were assessed.

Remediation Consulting, ARCO, North Slope*, Alaska*. Provided technical analysis of "how-clean-is-clean" issue, and remediation requirements for drilling mud sites on the North Slope, Alaska. Client had several hundred drill pits that required remediation. An assessment of potential water quality impacts of small quantities of organics (petroleum hydrocarbons, PAHs) and metals present in the drilling muds established the required extent of remediation. Assisted ARCO Alaska in negotiating appropriate cleanup levels, leading to significant savings in overall costs of closure of the pits.

Contaminated Groundwater Reuse, Santa Clara Valley Water District*, Santa Clara County, California*. Technical review of water quality issues surrounding reuse of contaminated groundwater through blending into municipal supply after treatment.

Phosphorous and Heavy Metals Control, Vallejo Wastewater Treatment Plant, *Vallejo, California.* Project Engineer for an optimization study of coagulation options for Vallejo Wastewater Treatment Plant for control of phosphorous and heavy metals.

Phosphorous Removal Research, City of Zurich*, Switzerland.* Research Director responsible for directing a two-year study of direct filtration of secondary effluent for phosphorous removal, City of Zurich, Switzerland.

Peer Review/Strategic Consulting

Evaluation of Long-term Operation and Maintenance Costs, Wyckoff Superfund Site, Washington Department of Ecology*, Bainbridge Island, Washington*. Served as one of eight members of an expert panel advising the Department of Ecology, Washington State, on technical options to address long term operation and maintenance costs associated with the Wyckoff Superfund Site on Bainbridge Island, near Seattle WA. The former wood treating facility requires containment and long-term management, the costs of which are the responsibility of the State of Washington. The expert panel evaluated technical options that would reduce or eliminate the long-term costs associated with the site, including additional removal of the DNAPL/LNAPL source materials (former wood treating chemicals).

Environmental Monitoring, Ideascope. Served as an expert on environmental monitoring. Participated in a strategic planning process for Hewlett-Packard's Analytical Products Division.

Groundwater Programs at UMTRA Sites, Environmental Restoration Program, Sandia National Lab and Lawrence Livermore National Lab, *Nationwide and Livermore, California.* Member of an Independent Review Team under contract to Sandia National Lab to review groundwater programs planned for UMTRA (Uranium Mill Tailings) sites, and to review environmental restoration program for the Lawrence Livermore National Laboratory.

Corrective Action Review of Confidential Waste Management Company, *Golder Associates*. Retained by Golder Associates as an expert to review proposed corrective actions at a TSDF owned and operated by a major waste management company.

Petroleum Site Closure Plans, Lawrence Livermore National Laboratory, *Nationwide*. Retained by Lawrence Livermore National Laboratory as member of an expert committee reviewing closure plans for petroleum release sites at ten military bases in California. Committee prepared evaluation of each site for closure under a risk-based corrective action (RBCA) approach. Also, a member of the Working Task Force assessing natural attenuation of chlorinated solvents at sites throughout the U.S. Work funded by DOD and DOE.

MBTE Treatment and Remediation, ARCO Chemical and Oxygenated Fuels Association, *Nationwide.* Retained as an expert on water treatment and remediation issues associated with MTBE in surface and groundwater. Providing on-going technical outreach to impacted parties, public agencies, and general public. Technical reports have been prepared on the following subjects: 1) Effectiveness and Costs of Soil and Ground Water Remediation Systems for MTBE; 2) Review of Technologies for Removing MTBE from Drinking Water; 3) Taste and Odor Study for Setting Secondary Drinking Water Standards for MTBE; 4) Impact of Small Gasoline Spills on MTBE in Ground Water; 5) Volatilization of MTBE from Surface Waters.

Peer Review and Expert Panels

National Research Council. Committee Chair for evaluation of future options for management of subsurface remediation in the United States and to prepare conclusions regarding strategies to reduce the long-term liability for soil and groundwater contamination at hazardous waste sites with significant groundwater contamination. 2009-2011.

Member, Board of Scientific Councilors, *advising the Office of Research and Development, U.S. EPA* on peer review issues related to research priorities and research management at EPA's research labs. Participating in peer review of several of the EPA laboratories. 2000-2003.

National Research Council. Committee Chairman for evaluation of alternatives for groundwater cleanup. The 1994 report provides a definitive statement on the capabilities and limitations of pump and treat, as well as other groundwater remediation alternatives. Numerous

policy recommendations were made in the report to improve the regulatory approach to groundwater contamination sites. Provided briefing to industrial, environmental, and governmental groups, including testimony before the House of Representatives Committee on Public Works and Transportation, as part of Superfund reauthorization.

Water Science and Technology Board, *National Research Council, Division of Earth and Life Sciences.* Chairman of the Water Science and Technology Board from 1989 to 1991. During this time, the Board managed or developed over 15 projects related to all aspects of water resources management. From 1995 to 1998, chaired the Board on Radioactive Waste Management, a Board responsible for evaluating the nation's strategies for management of radioactive waste.

Strategic Environmental Research & Development program (SERDP), *Scientific Advisory Board Member*. Member of the Scientific Advisory Board for the Strategic Environmental Research & Development program (SERDP), a DOD program providing funds for R&D projects in support for DOD's efforts to meet environmental requirements at operating military facilities. Served from 2001 to 2005.

Environmental Science & Technology, *Editorial Advisory Board.* Served on the editorial advisory board for the largest circulation environmental journal, Environmental Science & Technology, published by the American Chemical Society (ACS [1999-2003]).

United States Environmental Protection Agency, *DNAPL Expert Panel*. Co-chaired an Expert Panel advising USEPA on the issue of whether source remediation at DNAPL sites is justified given difficulties of characterizing and remediating DNAPL impacted sites. The Panel's report was published by USEPA in 2004.

National Research Council, Member, *National Research Council Committee, "Hydrologic Impacts of Forest Management Practices,"* 2005-2007.

Bechtel Hanford and the Department of Energy, Expert Panel, Hanford Site. One of eight members of the Hanford groundwater/vadose zone expert panel advising Bechtel Hanford and the Department of Energy on integrating and optimizing remedial efforts at Hanford site (1997 – 2001).

Wyckoff Generational Remedy Expert Panel, *Washington Department of Ecology,* Member, 2009-2010.

U.S. EPA Advisory Panel on DNAPL Source Remediation: Co-Chair. Prepared report on DNAPL Source Remediation, December 2003, presented results to directors of Office of Solid Waste and Emergency Response.

Independent Review Panel, Idaho National Engineering Laboratory, Member of Independent Review Panel, Idaho National Engineering Laboratory for the review of site-wide groundwater cleanup strategy, 2004.

Integration Project Expert Panel, Hanford DOE Facility, *Richland, Washington*. Vice-Chair, and one of eight panel members selected by DOE from list of 150 nationally recognized experts on site remediation at DOE facilities (1998 – 2002)

Neutral Expert, Groundwater Contamination, *City of Lodi, California*. Federal court appointed technical neutral expert to advise the judge on technical issues related to groundwater contamination for the City of Lodi, CA. 2002.

Expert Panel, Air Force Center for Environmental Excellence, *Massachusetts Military Reservation, Cape Cod, MA.* Chair of Expert Panel that prepared a report recommending strategies to reduce estimated $600M remediation costs while meeting regulatory and stakeholder concerns at the Massachusetts Military Reservation (1998).

Technical Reviewer, Various Publications and Guidance Documents, U.S. Environmental Protection Agency, *Nationwide.* Provided review of several reports, including, "Alternative Disinfection Strategies for Control of Trihalomethanes" (1987); "Granular Activated Carbon for control of synthetic organics in Drinking Water" (1985); "Control of Organics in Drinking Water" (1983); "Treatment Techniques for Controlling Trihalomethanes in Drinking Water" (1981).

AFFILIATIONS

Environmental Law Institute, Washington, D.C. Member, Board of Directors, (2009-2016).
Department of Defense Strategic Environmental Research and Development Program (SERDP), Member, Science Advisory Board, (2002 – 2005).
Member, DNAPL Scientific Advisory Committee for DOD research program (2007 - 2009)
Water Environment Federation, Member, Research Advisory Council, (1989-1991).
American Association for the Advancement of Science
Air and Waste Management Association
American Water Works Association: Chairman and Trustee, Research Division, 1981-1987; Member, Research Planning Committee, AWWA Research Foundation 1984-1987.Chairman,

AWWA Coagulation Research Committee 1980-1983; Member Project Advisory Committee, AWWARF Research Project, "Optimization of Air Stripping Process," 1987-1988; AWWA Filtration Committee 1979-1982; AWWA Organic Contaminants Committee 1985-1991; Virginia Section, Chairman, Water Quality Committee 1981-1983.

American Institute of Chemical Engineers

American Chemical Society

American Society of Civil Engineers

International Water Association

National Ground Water Association

Association of Environmental Engineering and Science Professors

National Academies Roundtable on Science and Technology for Sustainability, Invited Member, 2010-2012.

National Research Council, Washington, D.C.: Member, Water Science and Technology Board, 1986-1988; Chairman, Water Science and Technology Board, 1988-1991; Chairman, Committee on Groundwater Cleanup Alternatives, 1991-1994; Chairman, Board on Radioactive Waste Management, 1995-1999; Invited Member, Committee on Hydrologic Impacts of Forest Management Practices, 2005-2007; Report Review Committee, 2010 – 2012; Chair, Committee on Future Options for the Nations Subsurface Remediation Efforts, 2009-2012.

United States Environmental Protection Agency, Invited Member, Environmental Engineering Committee, Science Advisory Board, 2000-2004; Member, Board of Scientific Counselors, Office of Research & Development, 1996-2000.

Environmental Science and Technology, Member, Editorial Advisory Board, 1994-2002.

Environmental Progress Journal, Editorial Advisory Board, 1991-1995.

Hazardous Substance Research Center, Stanford University (one of five USEPA-funded research centers under Superfund law), Chairman, Science Advisory Committee, 1989-2000.

Water Resources Center, University of California, Member, Water Resources Planning Committee, 1990-1999.

USEPA Center Program, Advanced Environmental Control Technology Research Center, University of Illinois, Member, Scientific Advisory Committee, 1983-1986.

Water Pollution Control Foundation (WPCF} Groundwater Committee, Co-Chairman 1987-1989; WPCF Hazardous Waste Committee 1986-1991; California WPCA, Hazardous and Industrial Waste Committee, Member and Program Chairman 1984-1986.

International Federation of Consulting Engineers, (FIDIC), Member, Environmental Committee, 1991-1994.

PROFESSIONAL HISTORY

Geosyntec Consultants, Inc., Oakland, California, Senior Principal, 2010 to present.

Malcolm Pirnie, Inc., Vice President, Global Science and Technology Leader, 2008-2010; Vice President, National Science and Technology Leader, 2001-2008; Vice President and Manager, Northern California Operations, Oakland, CA, 1997-2001.

ENVIRON Corporation, Principal and Manager, Engineering Practice, Emeryville, CA, 1994 - 1996

Montgomery Watson, Senior Vice President and Director, Environmental Management Division, London, UK, 1993 - 1994

James M. Montgomery Vice President and Sr. Company Officer, Director of European Development, Walnut Creek, CA, 1991 - 1993; Vice President and Sr. Company Officer, National Technical Director, Industrial and Hazardous Waste Services, 1989 - 1991; Vice President and Manager, Hazardous Waste Department, 1984 -1989; Vice President and Sr. Project Manager, Reston, VA, 1980 - 1983; Principal Engineer, Walnut Creek, CA, 1977 - 1980.

Department of Civil Engineering, University of California, Berkeley, CA, Lecturer, 1976 - 1977

Swiss Federal Institute for Water Research (EAWAG), Duebendorf, Switzerland, Research Associate and Lecturer, 1972 - 1976

Department of Civil Engineering, University of California, Berkeley, CA Research Assistant 1969 - 1 972

Engineering Science, Inc., Oakland, CA, Engineer (part-time), 1967 - 1969

Peace Corps Volunteer, Guatemala City, Guatemala; Lecturer, University of San Carlos, Guatemala City, 1964 - 1967

Chevron Research Corporation, Richmond, CA, Process Engineer, 1963 - 1964

Department of Chemical Engineering, Stanford University, Stanford, CA, Research Assistant, 1961 – 1962

TECHNICAL ARTICLES

Peer Reviewed

Mobile, M.; Widdowson, M.; Stewart, L.; Nyman, J.; Deeb, R.; Kavanaugh, M.; Mercer, J.; Gallagher, D., 2016. **In-Situ Determination of Field-Scale NAPL Mass Transfer Coefficients: Performance, Simulation and Analysis**, *Journal of Contaminant Hydrology*, 187, 31-46.

Wildman, C.F., D.H. Gandhi, and M.C. Kavanaugh, 2015. **"Iodine Addition to Drinking Water for Perchlorate Mitigation: Engineering Feasibility,"** *Journal American Water Works.*

Deeb, R., J. Nyman, E. Hawley, M. Kavanaugh, and R. O'Laskey, 2014**. "Advanced Diagnostic Tools."** *Chlorinated Solvent Source Zone Remediation*, B.H. Kueper, H.F. Stroo and C.H. Ward, Eds. New York: Springer-Verlag, Inc.

Suchomel, E.J., M.C. Kavanaugh, J.W. Mercer, and P.C. Johnson, 2014. Chapter 2, **"The Source Zone Remediation Challenge**," in *Chlorinated Solvent Source Zone Remediation*, Springer. (Edited by B.H. Kueper, H.F. Stroo, C.M. Vogel, and C.H. Ward)

Ehlers, L., and M. Kavanaugh, 2013**. "Redefining the End Game for Groundwater Remediation,"** *Groundwater*, 51,(2), pg.170, March – April.

Stroo, H.F., A. Leeson, J.A. Marqusee, P.C. Johnson, C.H. Ward, M.C. Kavanaugh, T.C. Sale, C.J. Newell, K.D. Pennell, C.A. Lebron, and M. Unger, 2012. **"Chlorinated Ethane Source Remediation: Lessons Learned."** *Environmental Science and Technology* 46:6438-6447.

Elisabeth L. Hawley, Neven Kresic, Alexandra P. (Sandy) Wright, and Michael C. Kavanaugh **"Assessing the Current and Future Impacts of the Disposal of Chromated Copper Arsenate (CCA)-Treated Wood in Unlined Landfills,"** 2009, *J. Air & Waste Management*, 59: 332-342.

Kavanaugh, M., and Kresic, N., "**Large urban groundwater basins; water quality threats and aquifer restoration",** Chapter 6, in Groundwater Management in Large River Basins, IWA Publishing, 2008.

Kresic, N., Mikszewski, A., Manuszak, J., and Kavanaugh, M.C., 2007. **Impact of contaminant mass reduction in residuum sediments on dissolved concentrations in underlying aquifer**. *Water Science & Technology: Water Supply*, Vol. 7, No. 3 pp 31-39, doi:10.2166/ws.2007.064

Hawley, E., Deeb R., Jacobs, J. and Kavanaugh, M. 2005. **Treatment Technologies for Hexavalent Chromium**. Chapter 8. Hexavalent Chromium Handbook. CRC Press.

Stroo, H. F., M. Unger, C. H. Ward, M. C. Kavanaugh, C. Vogel, A. Leeson, J. A. Marqusee, and B. P. Smith. 2003. **Remediating Chlorinated Solvent Source Zones**. *Environ. Sci. & Technology*. June 1, 2003 37: 223A-230A.

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AWARDS AND RECOGNITIONS

2019 G.V. Loganathan Distinguished Lecture, Virginia Polytechnic Institute, Blacksburg, VA

2016 Elizabeth Rockwell Distinguished Lecture, University of Houston, Houston, TX.

2015 Perry McCarty Distinguished Lecture, Stanford University, Stanford, California

2013 Elected Fellow, Water Environment Federation

2012 Elected to the Academy of Distinguished Alumni, University of California, Berkeley Department of Civil and Environmental Engineering

2012 Abel Wolman Distinguished Lecturer, Water Science and Technology Board, Washington, D.C.

2006 Ernest Gloyna Distinguished Lecturer, Johns Hopkins University, Baltimore, Maryland

2005 Walter J. Weber Distinguished Lecturer, Ann Arbor, Michigan

2003 AEESP Distinguished Lecturer, WEFTEC, Los Angeles, California

2002 Samuel R. Greeley Award, Best Water Resources Paper, ASCE Journal 2000

1998 Elected member, National Academy of Engineering (NAE)

1994 Selected as one of the 25 top newsmakers in 1994, by Engineering News Record

1993 Kappe Lecturer, Sponsored by American Academy of Environmental Engineers

APPENDIX B

Michael C. Kavanaugh, Ph.D., P.E., BCEE – Other Expert Testimony within Past Four Years

Michael C. Kavanaugh
Deposition and Expert Testimony

Geosyntec consultants

YEAR	DEPOSITION AND/OR TRIAL TESTIMONY	COURT	CASE NO.	CLIENT	CASE NAME	RETAINED BY LAW FIRM/ATTORNEY
2019	**Deposition:** March 25, 2019	U.S District Court for the District of Delaware	06-451-SLR	Alcoa Corporation	Alcoa Inc., v. Alcan Rolled Products-Ravenswood LLC, et al.	Tatro Tekosky Sadwick LLP David Sadwick 213-225-7171
2018	**Deposition:** December 20, 2018	U.S. District Court Central District of California	SACV 03-01742-CJC	Chevron USA Corporation	Orange County Water District v. Unocal Corporation, et. al.	King & Spalding LLP Jeremiah J. Anderson (713) 276-7403
2017	**Deposition:** October 17, 2017	U.S. District Court District of New Jersey	3:15-6468 (FLW-LHG)	Amerada Hess Corporation	New Jersey Dept. of Environmental Protection, et al., v. Amerada Hess Corporation, et al.	Rawle & Henderson LLP Susan M. Dean (215) 575-4296
2017	**Deposition:** March 2, 2017	Superior Court for the State of Alaska, Fourth Judicial District at Fairbanks	4FA-14-01544 CI (Consolidated)	Flint Hills Resources Alaska	State of Alaska vs. Williams Alaska Petroleum, Inc., et al., Alaska	Ciresi Conlin Mathew R. Korte (612) 349-8500
2016	**Deposition:** February 22, 2016	U.S. District Court, Southern District of Mississippi, Eastern Division	2:13-cv-208KS-MTP	Hercules, Incorporated	City of Hattiesburg vs. Hercules, Incorporated	Baker, Donelson, Bearman, Caldwell & Berkowitz, PC Amy Lewis Champagne (601) 351-8912
2015	**Deposition:** September 18, 2015	Superior Court of the State of California for the County of Orange	30-2010-00423097	National Oilwell Varco, LP, and Varco International, Inc.	Gavin Kirk vs. Varco International, Inc., et al.	Norton, Rose & Fulbright, LLP Elizabeth Weaver (213) 892-9290
2015	**Deposition:** September 9, 2015	Montana Sixteenth Judicial District Court, Rosebud County	DV 12-42	Talen Montana, LLC	Colstrip AOC Litigation	Holland & Hart LLP Shane Coleman (406) 252-2166
2015	**Hearing Testimony:** July 22, 2015	Superior Court of the State of California, County of Riverside	CIV 239784, Consolidated with Case No. RIC 381555	State of California	State of California vs. Underwriters at Lloyd's, London and other London Market Insurers, etc., et al.	State of California Department of Justice Peter A. Meshot (916) 322-2500
2015	**Deposition:** February 27, 2015	Court of Common Pleas, Summit County, Ohio	2002-11-6854	Goodrich Corp.	Goodrich v. Affiliated FM Insurance Company, et al.	Brouse McDowell

APPENDIX C

Overview of PCBs

Appendix C

Overview of PCBs

1.1. Overview of PCBs

PCBs are a group of compounds comprised of two benzene rings (i.e. biphenyl structure), with ten locations to which one to ten chlorine atoms may be attached. Variations of the number of chlorine atoms and their relative positions on the biphenyl structure result in 209 possible PCB structures, called congeners. PCB congeners share similar chemical properties. They are hydrophobic (very low solubility in water), strongly sorb to organic materials, are practically inflammable, and do not readily break down in the environment by abiotic or biotic pathways. The vapor pressures of PCBs are low but of sufficient magnitude to produce airborne transport of PCBs (Johnson et al., 2006). Blends of congeners, named Aroclors, were manufactured in the United States by Monsanto from the early 1930's through 1977 to meet a variety of industrial needs (Anezaki et al., 2015; Erickson, 1997). Aroclors are referred to as Product PCBs throughout this report. In other countries, production continued through 1993 (Breivik et al., 2007).

1.2. PCB Regulatory Background

The Toxic Substances Control Act (TSCA) was initially passed in 1976. It regulated the use, manufacturing, processing, distribution in commerce, cleanup, and disposal of PCBs. In 1977, Monsanto voluntarily terminated production of PCB Aroclors (EPA, 1980) "product PCBs". This termination preceded TSCA's July 2, 1979 ban on PCBs in non-enclosed processes (Ecology, 2015a). However, TSCA amendments allowed for continued inadvertent production of by-product PCBs. In 1984, the USEPA promulgated an exemption for the inadvertent generation of by-product PCBs at concentrations <50,000 parts per billion (ppb) which were either inadvertently generated as a by-product or impurity resulting from a chemical manufacturing process, or products containing concentrations <50,000 ppb due to the historic use of legally manufactured product PCBs (Ecology, 2015a). The exemption rule requires that the concentrations of these by-product PCBs in industrial products not exceed an annual average of 25,000 ppb, with the exception of detergent bars, which are limited to 5,000 ppb (Ecology, 2015a). In 2013, the EPA re-affirmed the by-product PCB exclusion rule:

> "*EPA is adopting the generic 50 ppm exclusion for the processing, distribution in commerce, and use, based on the Agency's determination that the use, processing, and distribution in commerce of products with less than 50 ppm PCB concentration will not generally present an unreasonable risk of injury to health or the environment*" (Federal Register Vol. 78, No 66, April 5, 2013).

In 1992, under the authority of the Safe Drinking Water Act (SDWA), the EPA established a Maximum Contaminant Level (MCL) of 0.5 parts per billion (ppb) total PCBs as the drinking water criterion for this group of organic chemicals. However, as of December 1990, Washington

State established a more stringent drinking water criterion for total PCBs in groundwater of 0.01 ppb (WAC 173-200-040).

In November 1999, the National Toxics Rule (NTR) set a criterion for total PCBs in surface water for the State of Washington at 170 ppq (40 CFR Part 131, Federal Register Vol. 64. No. 216 November 9, 1999). In 2013, the USEPA adopted a surface water total PCB criterion of 1.3 ppq for waters within the Spokane Indian Reservation, and in November 2016, the 170 ppq State of Washington criterion was lowered to 7 ppq based on revised fish consumption and exposure assessments (EPA, 2013; 40 CFR Part 131, Vol. 81, No. 228, November 28, 2016). The upstream surface water criterion for the State of Idaho has, meanwhile, remained unchanged at 190 ppq since 2002. On May 10, 2019 the EPA withdrew the previously promulgated criteria for the state of Washington and re-approved the criteria submitted on August 1, 2016. This re-established the surface water criterion for PCBs to 170 ppq (USEPA, 2019).

In 1977, the Food and Drug Administration (FDA) established the total PCB content of commercially sold food products with the following standards (21 CFR Part 109, Federal Register 52819 No. 30, September 30, 1977):

- Fish – 2,000 ppb
- Milk – 1,500 ppb
- Poultry – 3,000 ppb
- Beef – 3,000 ppb
- Eggs – 300 ppb
- Fish food – 2,000 ppb
- Food packaging material – 10,000 ppb

These standards continue to be supported by the FDA as protective of public health for commercially sold food and food products. A summary of relevant State and Federal regulations and guidance for PCBs in various media is presented as Exhibit C-1.

1.3. By-product PCBs in Municipal Products

PCBs can be unintentionally produced as by-products in a number of chemical processes that contain chlorine and hydrocarbons. These by-product PCBs are not related to PCBs manufactured by Monsanto (Erickson, 1997). One of the most studied examples of by-product PCB generation occurs during the production of yellow, white and green pigments. These by-product PCB-containing pigments are present in a wide variety of commercial products, such as paint, paper, ink, food packaging, plastic bags, and road marking paints (Rodenburg et al., 2009). These products are sold and transported around the world. During use and after they have been discarded, degradation of the products results in PCB-11 entering wastewater and stormwater streams (Rodenburg et al., 2009). While over 50 congeners have been detected in pigments, the congener most often produced is PCB-11 (Vorkamp, 2016; Hu and Hornbuckle, 2010; Grossman, 2013; Exhibit C-2).

EXHIBIT C-1

Summary of PCB Regulations for Various Media

Medium	Agency	Statute	Human Health Criteria	Measurement Units	Reference
Fish Tissue	FDA	Federal Food, Drug, and Cosmetic Act	2,000	ug/kg	21 CFR 109.30
	USEPA (calculated)	Calculated based on National Toxics Rule (Clean Water Act)	5.3	ug/kg	This is not in the NTR but the Fish Tissue Equivalent Concetration (FTEC) based on 170 pg/L NTR standard is referenced frequently
	USEPA - Screening	Guidance for fish advisories	20 - Recreational 2.45 - Subsistence	ug/kg	EPA screening values for recreational/Subsistence fishers EPA 823-B-00-007
	Washington DOH	Guidance for fish advisories	23	ug/kg	https://fortress.wa.gov/ecy/publications/documents/1003007.pdf
	Washington	Calculated based on National Toxics Rule for Washington State (Clean Water Act)	0.22	ug/kg	Calculated FTEC based on 7 pg/L std.
	Spokane Tribe	Calculated based on Surface Water Quality Standards established by Spokane Business Council	0.04	ug/kg	Calculated FTEC based on 1.3 pg/L std.
Surface Water	Federal (USEPA) - NTR	Clean Water Act	0.000170	ug/L	USEPA, Federal Water Quality Standards Applicable to Multiple States. Federal Register Vol 64, No. 216, Tuesday, November 9, 1999/Rules and Regulations
	USEPA - Ambient Water Quality Criteria	Clean Water Act	0.000064	ug/L	USEPA, National Recommended Water Quality Criteria - Human Health Criteria Table
	Idaho	Clean Water Act	0.00019	ug/L	https://adminrules.idaho.gov/rules/current/58/0102.pdf
	Washington	Clean Water Act	0.00017	ug/L	USEPA, 2019. Federal Register Vol 84. No 151. Tuesday, August 6, 2019/Proposed Rules
	Spokane Tribe	Surface Water Quality Standards established by the Spokane Business Council	0.0000013	ug/L	Spokane Tribe of Indians Surface Water Quality Standards
Commercial Products	FDA	Federal Food, Drug, and Cosmetic Act	10,000	ug/kg	21 CFR 109.30; Food packaging material
	TSCA	TSCA	25,000 (max. 50,000)	ug/kg	40 CFR 761
Soil	TSCA	TSCA	50,000 (screening level) 1,000 (cleanup goal)	ug/kg	Soil remediation 40 CFR 761
Groundwater	Washington	Washington Administrative Code	0.01	ug/L	http://apps.leg.wa.gov/WAC/default.aspx?cite=173-200-040
Sediment	Washington **	Washington Administrative Code	65,000 (screening level) 12,000 (cleanup goal)	ug/kg OC	WAC 173-204-562
Drinking Water	USEPA	Clean Water Act	0.5	ug/L	MCLs

Notes:
TSC - Toxic Substances Control Act
FTEC - Fish tissue equivalent. Calculated by multiplying the human health criterion by the PCB bioconcentration factor (BCF) of 31,200
NTR - National Toxics Rule
USEPA - United States Environmental Protection Agency
** Marine and low salinity sediment cleanup objective of 12 mg/kg organic carbon and cleanup screening level of 65 mg/kg organic carbon
ug/L= micrograms per liter (ppb liquid measurement)
ug/kg= micrograms per kilogram (ppb solid measurement)
OC - concentration normalized based on percent of organic carbon in the material i.e. a concentration of 650 ug/kg in sediment with 1% organic carbon = 65,000 ug/kg OC

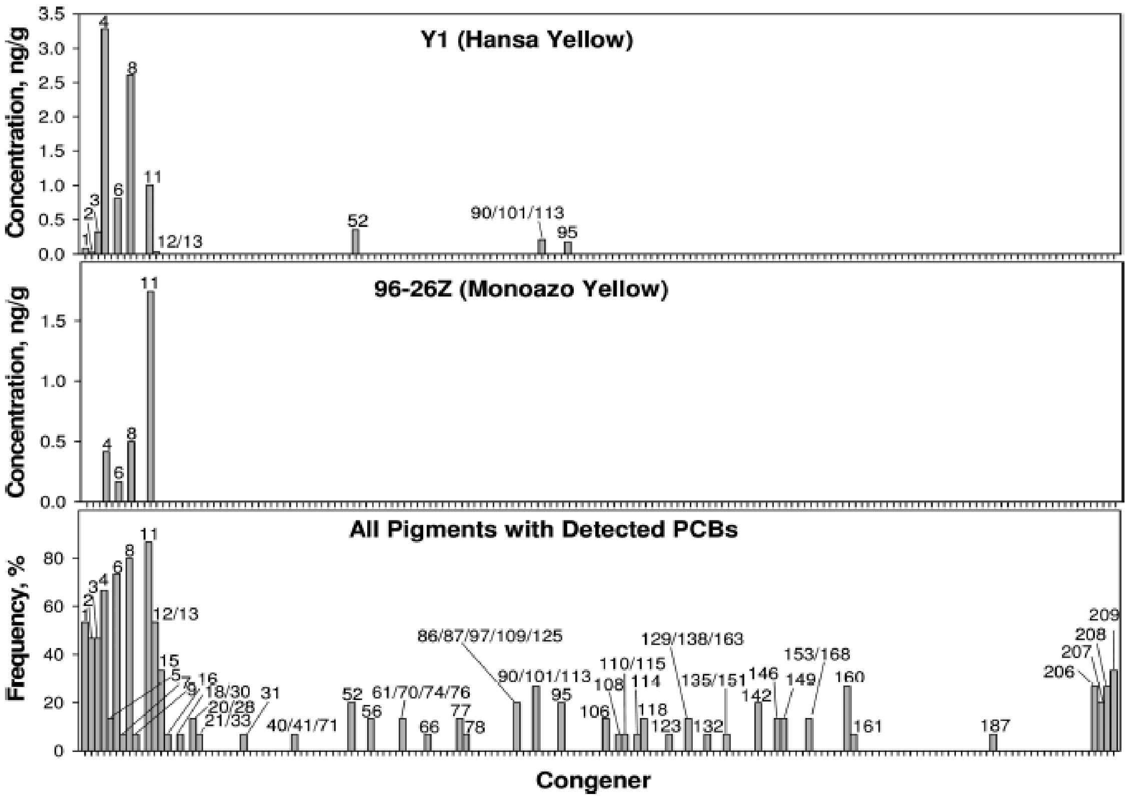

Exhibit C-2: Example of additional Inadvertent Congeners Found in Pigments
Source: Hu and Hornbuckle, 2010.

Because PCB-11 was present only at extremely low levels in product PCBs and it is a very unlikely product of microbial or photolytic degradation or incineration (Rodenburg et al., 2015), it is commonly used as a marker to identify the presence of by-product PCBs in the environment (Hu and Hornbuckle, 2010). Recognizing the need to understand the effect of inadvertent congeners on local waters, Ecology's Hazardous Waste and Toxics Reduction Program conducted a study on consumer products (Stone, 2014). Ecology tested 74 samples of products purchase from local retailers. The products fit into five categories: product packaging, paper products, paint and paint products, caulks, and miscellaneous food products and printer inks. Of the 74 samples, 49 samples contained PCB-11, with concentrations ranging from 1 to 48.5 ppb. The highest concentrations were found in a package for Ritz Handi-Snack Crackers (48.5 ppb), a medium yellow colorant pigment (45.0 ppb), and an interior/exterior yellow spray paint (29.7 ppb). The highest congener concentration measured was 320 ppb of PCB-209 in the universal paint colorant—phthalo green.

Ecology concluded:

> *"Given the wide distribution of PCB-11 in consumer products, consumer products are a continuing and new source of PCB contamination and generation of PCB-11 is mostly an unregulated source of PCB contamination"* (Stone, 2014; p. 34).

Expanding upon the Ecology Study, the City commissioned a report evaluating the presence of by-product PCBs in its own municipal products. Of the 41 municipal products tested, 39 contained by-product PCB congeners, with concentration ranges listed below (City, 2015).

- Traffic marking paint (0.28 ppb – 64.88 ppb)
- Thermoplastic traffic tape (3.33 ppb – 10.78 ppb)
- Hydrant paint (0.0032 ppb)
- Utility locate paint (21.527 ppb)
- Dicer (0.038 pg/kg – 1.952 ppb)
- Antifreeze (0.018 ppb)
- Pesticides (Non-Detect – 6.89 ppb)
- Motor Oil/Lubricant (0.502 ppb – 2.375 ppb)
- Gasoline and Diesel (0.935 ppb)
- Emulsified Asphalt Dust Suppressant (0.091 ppb – 3.574 ppb)
- Asphalt products (0.085 ppb – 7.975 ppb)
- Hydroseed (2,509 ppb)
- Pipe material: (1.11 ppb – 17.78 ppb)
- Firefighting Foam: (0.029 ppb)
- Cleaners and Degreasers: (0.003 ppb – 0.068 ppb)
- Personal Care Products: (0.032 ppb – 0.174 ppb)

A wide range of congeners were identified in these products, and the results of these studies are anticipated to be used for by-product PCB tracking and reduction activities in the future (City, 2015).

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40 CFR Part 131, Federal Register Vol. 64. No. 216 November 9, 1999

40 CFR Part 131, Federal Register Vol. 78, No 66, April 5, 2013

40 CFR Part 131, Federal Register Vol. 84, No. 151, August 6, 2019

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